FIRST GET-TOGETHER OF RESEARCH AND INDUSTRY

December 20–21, 1965

ADDRESSES AND KEY PAPERS

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH, NEW DELHI

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PREFACE

Sometime back Shri M. C. Chagla, Vice-President, CSIR and Union Minister for Education had suggested that the CSIR may organise a Get-Together between the scientists and representatives from Industry in order to enable a better awareness of the problems and difficulties of the Industry by the Scientists and appreciation by the Industry of the role of scientific research in industrial development. I had given considerable thought to the organisation of this Get-Together. The economic crisis and the extremely critical foreign exchange situation have made the tasks before the scientists and the industrialists in the country difficult and challenging. In the context of this situation it was appropriate that this Get-Together devoted particular attention to the problems of:

(i) Development of substitutes for the imported raw materials
(ii) Indigenous manufacture of essential components hitherto imported
(iii) Development of indigenous know-how at a sufficiently advanced level as to be commercially utilisable in respect of those articles on which repeated foreign collaboration has been sought
(iv) Measures through which the programmes of industrial research could be oriented to the needs and requirements of industry

With these objectives in view, the Council of Scientific & Industrial Research addressed various industries and institutes for their comments and suggestions. This received wide response from Government Departments, Industry and Research Institutes. Papers were subsequently invited with a view to outlining suggestions for research and development aimed at import substitution, export promotion, meeting defence requirements, increasing food and agricultural production and industrial research and development policies. Fifteen Working Committees were constituted embracing related Groups of industries. These Committees scrutinised the 400 and odd papers received for discussion and prepared Key Papers for formulation of recommendations at the Get-Together held on December 20–21, 1965. The recommendations were further discussed at a meeting of Conveners on February 7 & 8, 1966. The proceedings and final recommendations have been published earlier. This volume contains the gist of speeches delivered by Ministers, industrialists, scientists and others giving the guidelines for the deliberations and also the Key Papers prepared by the 15 Working Groups. A list of papers presented at the Get-Together is given in Appendix 1. Some of these papers, marked by asterisks, having a bearing on the scope of the Get-Together are being published separately.

Husain Zaheer

Director-Gene
Scientific & Ind ial Research

New Delhi
April 4, 1966

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Opening Session

(December 20, 1965)

FISH TECHNOLOGY EXPERIMENT STATION
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Welcome Address

DR S. HUSAIN ZAHEER
Director-General, Scientific & Industrial Research

SHRI M. C. CHAGLA, SHRI T. N. SINGH, SHRI ASOKA MEHTA, FELLOW SCIENTISTS, DELEGATES TO THE GET-TOGETHER AND FRIENDS :

On behalf of the Council of Scientific & Industrial Research, on behalf of the community of scientists of the CSIR and on my own behalf I have great pleasure in welcoming you to this Get-Together of Research and Industry. Actually this Get-Together is being held in pursuance of an order we received, a few months back, from the Minister for Education and Vice-President of CSIR, Shri Chagla who felt that it would help in bringing research closer to industry and create a better understanding of the problems facing research institutes in the matter of utilisation of results of research if scientists and users from industry could be brought together in a close intellectual association of this type. We gladly welcomed the proposal since during the last three years or so, we have been making earnest efforts to orient the research programmes of the laboratories, so that they have a direct relation with the industrial and economic plans of the country. Actually this was one of the primary directives of the late Prime Minister, Shri Jawaharlal Nehru when he appointed me Director-General just over three years ago. On the one hand we have tried to bring ourselves in closer association with the departments for industrial planning and development such as the Planning Commission, the Directorate-General of Technical Development and the Ministry of Industry; on the other we have also tried to win the confidence and trust of the industrial firms and the forward looking sections of different sectors of industry. We have met with considerable success and the measure of it can be seen from the response that we have received for this Get-Together. Out of the 700 and odd delegates who had sent written intimation papers expressing their intention to participate in the discussions in the Working Groups, about 400 belong to the public and private sector industries. We have received 400 papers for discussion and comments. Of these again more than half are from technical personnel from industry. Most of the participants are scientific and technical personnel from industrial firms who are familiar with the economic, technical and operational problems of their industries. It is this fact which gives me the hope that this Get-Together will be productive of technically sound ideas and recommendations in the form of projects and programmes for research in the laboratories or as joint projects between laboratories and industries. From the CSIR point of view most of our laboratories are now fully geared for undertaking industrial research with clear objectives and time targets. Most of the work has been project oriented and a publication on the research projects and pilot plants of the laboratories has been brought out by the Research Coordination, Industrial Liaison & Extension; the Defence Coordination; the Research Schemes Units and Publications & Information Directorate of the CSIR. This should form the basis of understanding as to what is actually happening and is in progress in the research laboratories. Every effort should now be made to improve upon this programme and undertake projects which have a direct impact on the crucial problems facing the country. As many as 266 projects of interest to defence effort and nearly 400 dealing with substitution of raw materials or imported components or alternative technologies to imported know-how are in progress in the laboratories. This is a sizeable effort whose effectiveness could be further improved by adding to them selected projects dealing with substitution of imports of high value or of strategic nature.

The country is passing through a serious economic crisis. The National Emergency which started with the Chinese aggression in 1962 has been further aggravated by the second Pakistani aggression against our borders in 1965. The food situation in the country is critical and foreign exchange has touched its lowest ebb. The country has all these years been brought up on an assumption of continuing aid for industrial development and most of our industries are based on foreign technical collaboration and financial assistance. Since the last 18 years after Independence the country has progressed in its industrial development but has become increasingly dependent for essential raw materials, components, spares and further technical advances on other countries. This is a paradoxical state of affairs and should cause serious concern to every thinking citizen, more particularly the scientists and the technologists. Since the stoppage of most of the foreign aid consequent upon Pakistani aggression, a new upsurge of self-dependence, self-reliance and self-sufficiency is sweeping the country. This has created a climate where indigenous know-how and indigenous research has greater chances of utilisation than it had before. It is now the task of the scientists and the technologists to translate this political and emotional upsurge into a physical reality. It is the scientist and technologist who is the kingpin of the technological revolution and the technological self-dependence. He can fulfill his role only by undertaking tasks and projects of direct relation to defence, agriculture, import substitution, export promotion, conservation of scarce materials and improvements in technology. The research institutes must function in close harmony with the users and the scientific personnel from the laboratories and technical personnel from industry must be closely linked in their endeavours to make industry self-dependent.

Some of the papers presented in the Get-Together define broadly national tasks in terms of physical gaps of imported raw materials, plant and equipment, machinery and strategic items. These physical gaps must now be translated into tasks where research and technical personnel can help. These should form the basis of research efforts of the institutes sponsored by the Government and by the private industry itself.

We have tried to organise this Get-Together in a spirit of austerity without 'at homes', dinners or variety shows, excepting for a cup of tea during tea breaks. After this Opening Session at which we have requested Shri Chagla and the Minister for Industry, the Deputy Chairman of the Planning Commission and other leaders of science and industry in the country to outline what they consider to be broad tasks before the scientists in the research laboratories and industry, this Get-Together will divide itself into 15 Working Groups. It will be the task of the Working Groups to thoroughly discuss the main key papers before them and after 6 hours of discussion and deliberations on the Key and other papers in their Working Groups, spell out in specific terms the tasks before the scientific and technical personnel in their respective fields. We hope some laboratory, inter-laboratory, laboratory-industry and laboratory-university-industry projects may emerge from this Get-Together which will have a direct bearing on the industrial and economic advancement of the country. We would like the Working Groups to spell out these tasks in terms of short-term, medium-term and long-term projects and we will make every effort to implement these. One prominent industrialist has written to me that machinery should be set up to ensure the implementation of the worthwhile recommendations. I hope the Working Groups will also try to define the type of machinery that could be set up for the implementation of their recommendations. Each Working Group will function under the guidance of a Chairman who has been specifically requested to keep the discussions away from generalities and vague speeches. I have every confidence that under the guidance of this selected group of Chairmen and the Conveners, we will get worthwhile recommendations.

The Convener of this Get-Together, Shri Baldev Singh, the Conveners of the Working Groups and a large number of members of the staff at the CSIR Headquarters and the laboratories have worked day and night to provide material in the form of papers to the participants. Most of this material has been in the hands of the participants well before the Get-Together. The efforts of these colleagues would have been rewarded if the Working Groups bring forth specific and concrete recommendations for research projects. Recently the Government of India has taken the wise decision that scientific research will rank in terms of priority along with defence and agriculture—that money will be provided and will be forthcoming for worthwhile projects. This is in recognition of the fact that the value of the scientific research is appreciated in terms of its contribution to the defence, industrial and economic development of the country. I sincerely hope that this confidence that the government has placed in scientific research and the scientists of the country will be fully justified. This is for the first time in the history of our country that a confrontation between Industry and Science is taking place on a national scale. A dialogue must ensue and I have no doubt that given the scientific spirit and temper, it will bring great benefits to our country.

I am grateful to Shri Chagla, Shri T. N. Singh, Shri Asoka Mehta and others who have been good enough to find the time to be with us today and to all the delegates who have agreed to participate in the Working Groups. I now request the Chairman, Shri Chagla to address us.

Chairman's Address

Hon'ble Shri M. C. CHAGLA
Chairman, Get-Together of Research and Industry

Ladies and Gentlemen :

This is the first time that I have been thinking of having a Conference like this where Ministers, Professors of Science and Industrialists must come together to discuss their mutual problems. I am very happy indeed that this Conference is ultimately being held today.

I need hardly say that in the present crisis that faces our country each section of our society must make its contribution and help the country to tide over the crisis. Science must think of its own contribution and even more important for science and industry is to make their contributions in collaboration with each other and also devise ways and means for it. The first and foremost way in the present crisis is to safeguard our security and integrity. As you know we have suffered from naked, unabashed and unprovoked aggression from Pakistan. Thanks to our jawans who have met the aggression bravely. But the threat still continues and we cannot afford to lower our gross vigilance or watch over it. We need weapons; we need arms; we need armaments to meet the challenge.

The other aspect of our crisis is the food shortage. Population in India is growing apace much faster in spite of the Family Planning Programmes. But with all this there is acute shortage of food. Nature has also been too unkind to us. There have been droughts in different parts of the country which have added to the problem. We have shortage of foreign exchange. There are many things that we have to import and for that we need all the foreign exchange that we have, so that we could utilise it for the best purpose of our country. The result has been, as you know, we have serious cuts in our imports. I hope my friends in the industry will not misunderstand me. Industry in our country is a protected and sheltered industry unlike in the West. It is for this reason we have no imports to compete with what our industry produces and so there is no competition with advanced countries like the USA, the UK and other European countries. There is another factor which makes the industry protected and sheltered. You are now functioning in a market of scarcity. The demand is so great that you are not in a position to satisfy the men and, therefore, whatever you produce will be accepted in principle. There is more demand and the consumption is growing rapidly and as such industry is not in a position to satisfy the rising demands of the people.

Therefore, situated as it is, it is the duty of the industry to meet the challenge that the country has thrown today. It is true before independence, we used to export raw materials and the textiles that were manufactured outside were sent back to us. The late Prime Minister realised the importance of an industrial base of our country. He realised that ours was a critical economy. He took the view that unless we build an industrial base to our agricultural economy we could never transform our

CHAIRMAN, SHRI M. C. CHAGLA ADDRESSING THE GET-TOGETHER OF RESEARCH AND INDUSTRY

A VIEW OF THE AUDIENCE

society from a poor one to a prosperous one, and therefore, he did everything he could do in his powers to accelerate the pace of industrialisation in our country.

Today, we have 27 laboratories in our country. We have the CSIR which looks after these laboratories. All this was the work of our late Prime Minister. He had the imagination, the vision and the statesmanship to realise that without scientific research industrialisation of this country was impossible. Not only the country needs basic research or fundamental research but economic research and the industrial application of science for the benefit of the people and, therefore, these laboratories set up by him, were intended for applied research, operational science and not for basic research which was carried out mostly in the Universities.

I think, even the most optimistic and sceptical industrialists of our country will admit and acknowledge that after 18 years of Independence our industry has expanded tremendously. If we try to compare the situation existing in 1947 with the situation prevailing today, we must admit that there has been tremendous expansion to the industry in our country. But there are many shortcomings and it is our duty today to face these shortcomings and try to tide over them.

The first shortcoming to which I attach the greatest importance is that there is too much dependence on foreign assistance. I do not know whether it was purely a good thing or not but it is definite that after Independence we got a large volume of foreign assistance. Without that foreign aid, it was impossible for us to progress at that time. I often give an example that a man walking with crutches gets accustomed to it. He forgets to stand on his own feet. The time has now come when we should throw away these crutches. We have our own feet, good feet and strong feet—and we must depend on them and not on these crutches.

There is too much dependence on foreign know-how. Our scientists, engineers and technicians are equally talented and gifted with the necessary skill and calibre and are capable of developing the necessary know-how to set up new industries. But we are always looking for foreign know-how. We have no confidence in our own men. And again the time has come when we should try to place full confidence in them. The third shortcoming is that new industries are being set up without taking into consideration the existing industries' working capacity. The fact remains that there are industries of that type already existing and yet we are in an indecent hurry to set up new industries. It is very important to bring about proper via media between the necessity of starting a new industry or to improve the working of the existing industry in the country.

The fourth shortcoming is that there is too little collaboration with our laboratories. As I said, the very purpose of setting up these laboratories was to help the industrialisation of the country and to give to the industry the results of technical knowledge which has extended so greatly. The aim was to make use of the scientific developments and knowledge for practical purposes of the industry and the individual. This could have been only achieved if there was close liaison and collaboration between industry and science. And finally industry has attached too little importance to scientific research. I do not think anywhere in the world where industrialisation is going on, so little importance is being attached to scientific research by industry as it is in India. Even an ordinary industrialist in the country thinks that any money spent on science is just a wasteful expenditure. He thinks that any money spent on science will not bring him any prosperity. But this is entirely an erroneous approach. In the foreign countries the position is entirely different. They spend millions of dollars voluntarily on conducting research and at their own initiative, even before the Government actually comes forward to take up research work in that specified field and spends money on its own behalf. They think that money spent on research work is for fruitful purposes. They, therefore, draw up their research programmes well in advance realising that although a particular research may not yield immediate results, ultimately it is likely to produce gainful results. It is this mentality which our industry should emulate and develop and realise the importance of scientific research in our country. Now how to get over these shortcomings!

The first and the foremost suggestion I would like to make is precisely the same and whatever the Prime Minister has been saying from time to time emphasising the importance of scientific research and that is what we have to adopt as a slogan "Self-reliance". It is not merely something you say on the platform but it has to be translated into concrete terms as far as industry is concerned. Self-reliance can only come if you make up your mind to do without imports or do with as too little imports as possible. It means, try and find out whether you cannot substitute for the things which we are importing.

The second suggestion that I would like to make is "trust our own know-how". That is the most important part of self-reliance. So far we have been using foreign know-how and in certain cases, I know, it might be unavoidable. The foreign know-how may, no doubt, be imported but that must be fully developed and exploited by our own young scientists and engineers in the country so that they may get benefit out of it. Take the example of Japan, which is known as one of the famous copyists in the world. She has imported things from all over the world but given to their scientists to do research and supply know-how to the industry. Their objective was to copy the things and try to design and fabricate themselves so that they may be able to stand on their own feet. How a small country like Japan has become one of the great innovators and a leader in science and technology is worth emulating. So whatever may be the objective, we must try to stand on our own feet; that should be the motto.

Industry must shed away the shyness and learn to take its problems for solution to the National Laboratories. Our laboratories exist to solve their technical problems. Every industry has somewhat technical problems of their own. It is possible for our scientists to find substitutes. In almost all or in many of the articles there is a foreign component. It may be that these foreign components can no longer be imported. Foreign exchange is necessary for imports of these foreign components. We should try and find out whether we can manufacture these components ourselves and our laboratories are there to help you to solve these problems.

Take the raw materials which are essential for manufacturing engineering goods or other goods. You have to try and see whether you can find substitutes in our own country. Our laboratories are making alloys, zinc, and copper which were so far being imported. We should design and manufacture our own machinery and equipment. This is the one sector where we have to use the greatest amount of foreign exchange and have to depend upon foreign countries. Our country can never make real advance unless we learn to design and fabricate our own equipment and our own machinery. Here again go to our laboratories, ask them to set up pilot plants and tell them what you need. Our laboratories are already setting up pilot plants for the use of industries.

The other two problems in which our laboratories can help the industry are reduction in cost and improvement in quality. There is a general complaint that the Indian quality is not good and cost is higher. In India where labour is so cheap and raw material is so readily available, we should be able to export in a manner which would make it possible for us to compete with most industrialised countries in the world. For this purpose, our laboratories, which are fully equipped, are in a position to help them. They can produce things which cost less and can also suggest ways and means to improve the quality.

Suppose all imports are stopped all of a sudden and we have no foreign exchange, will it mean that the industry will come to a standstill? Necessity is the mother of invention, let us say "necessity is the mother of scientific research". The greater the necessity, the quicker the scientific research, the more the results. Scientific research has received acceleration in UK. During the Second World War, most of the ships carrying the warfare goods to England had the constant danger of the submarines and warships to keep constant watch over them. Exactly the same conditions exist in India today and we are required to guard ourselves against such eventualities. On the one hand we have the threat from Pakistan and China and on the other from our growing poverty.

I have been saying constantly of industry going to science but collaboration must be a 'two-way traffic'. It is not enough that industry should go to science but it is equally essential that science should go to industry. I want our scientists to visit industrial units, factories and plants and find out what the difficulties are, what their problems are, guide them, counsel them and advise them to surmount their difficulties.

Every large industry should have a small scientific cell. In this respect, I welcome the establishment of Industrial Cooperative Research Associations where scientists and industrialists should sit and work together and find solution to their intricate problems.

The other day I was in Bombay and I was very much amazed to see work done by SASMIRA on artificial fibre. Such sort of cooperative associations should be formed which should be defence-oriented.

In conclusion, I would suggest that Small Working Groups should aim at:

(1) How to satisfy the urgent national needs of self-dependence of our own know-how.

(2) How to make better use of scientific talent available in the country.

(3) How to step up production in industries which have been newly established so that they can work to their full capacity.

(4) Finally the industry is to be protected and sheltered but it has given all the advantages. I think industry owes a duty to society also. It has not suffered competition. Industry can produce anything, any quality and future industry should see that in competition protection and shelter should not cease.

I, therefore, must say that industrialisation and scientific research have no meaning unless we raise the standards of living.

Speeches

Hon'ble Shri T. N. SINGH

Union Minister for Industry

The Working Groups should address themselves to certain urgent tasks such as a large-scale programme of import substitution, import avoidance and diversification of production with a view to keeping machinery and equipment engaged. The present crisis, in my view, has made the country recapture the spirit of "Swadeshi" during the freedom struggle.

All these things cannot succeed without science. So far we have been dependent so much on foreign collaboration and assistance but the time has now come when it can be stopped. Today, we are facing very serious problems. First is how to keep our industry going. We have so far been depending on foreign collaboration, and to me, it is really a matter of great satisfaction that we have gone back to our own slogan. I have tried to go to various industries. I concede that we are suffering from a kind of complex from where we cannot think and do without any foreign exchange and foreign collaboration but I can assure you, Mr Chairman, that we in the public sector are determined to do it without foreign exchange, and we shall do it. More important is that our own engineers and technicians are very keen of finding solution of the problems and in many cases the results have been very amazing and fruitful. So I have been going to the industry and telling them that if one industry is not big enough to have its own apparatus and the necessary equipment let them have scientific units for this purpose. We have made a start in heavy electricals and we will do so in other cases also.

There are financial difficulties. Though there is shortage of funds, yet there is greater response from our engineers and young scientists that they can do it without foreign collaboration. I would strongly suggest that we should take up urgent problems. Attention should be given immediately to doing away with some of imported components and parts.

Secondly, we should do something on a fresh basis in regard to substitution of alloys and non-ferrous metals wherever we can find from our own resources. That is holding up a large part of the work. For instance in galvanizing process it is possible to substitute zinc coating by electrolytic process. The processes that are evolved in the laboratories remain for too long a period in the laboratories. And they do not come on the grounds very quickly and in short time. There is reason for this but we cannot wait for long. Laboratories should be quick in giving processes for industrial application.

We have been hearing about aluminising for the last many years but nothing has been achieved as yet. I am very sorry to point out this but there are many things in which only the discovery is not desirable. The industry wants something more than the mere discovery and we must find ways and means to develop and to bring to the forefront of the industry what are the results of our research. We have also a conservative outlook. To illustrate one instance, for too long we have been hearing of ferro-manganese but I feel that during the past 18 years or so we have not been able to develop any indigenous technical know-how. The vested interests have come in our country to a greater extent during the last 18 years and this does not want our indigenous know-how to develop. We have to fight this vested interest too.

Rolling industries which are already working feel that they cannot change over. Our industrialists are more keen than anyone else to do things which we have got to do. Even the industry will come forward to do the work on our own self-reliance. In the end I would like to say that there has to be a great sense of urgency and stoppage of foreign assistance. For this our services from the industry angle are always available.

SHRI ASOKA MEHTA

Deputy Chairman, Planning Commission

Mr Chairman, I am grateful to you for inviting me to participate in this Get-Together of Research and Industry, and I welcome the decision to hold the conference which I think would turn out to be a creative commingling between Science and Industry. India is no longer completely undeveloped and yet it is not fully developed.

There has to be a great amount of piecing together what we have achieved since independence, fill gaps and identify those where corrective action has to be taken either we can let frustration grow in the next ten years or have a period of excitement and fulfilment. It all depends on our attitude and the cooperative effort we bring to bear on our problems. I, therefore, emphasise the need to reduce waste in scarce materials and ensure quality control.

Being in the Planning Commission I am perhaps in a favourable way as compared to my other colleagues to judge and watch the economic progress of the country from time to time and even to share a large amount of its criticism too.

As you know, the industrial production of the country is likely to be doubled in the next five years. We have therefore to pass through a period of profound and critical importance in the coming ten years in the face of certain developments. Unless we bring about qualitative changes with the qualitative developments, we shall find ourselves completely in disarray. I would, therefore, like to impress upon the scientists and the industrialists to have a very clear idea of the deepening and diversification of economy and evolve a meaningful programme of cooperative action to meet the challenge. I, therefore, welcome the functioning of these working groups at this hour. Though it may be slightly late when we have embarked upon this unique activity, yet however, I think that these Working Groups will produce pin-pointed and purposeful recommendations which would be taken into account in formulating and finalising the Fourth Plan. It is estimated that the import requirements of the components and spares for the various machineries and equipment is likely to touch the figure of Rs 15 crores as envisaged in the Fourth Plan and if we are in a position to develop our indigenous resources substantially we would be able to exercise a good cut on our resources. Secondly, there could also be a big saving in enormous expenditure estimated at Rs 700 to 800 crores on design, engineering and consultancy work in the next few years due to the development of our own know-how. I, therefore, feel strongly that efforts should be made to develop our own technical and indigenous know-how. With these words I thank you Mr Chairman again and wish this Get-Together a grand success.

SHRI K. RAGHU RAMIAH

Union Minister for Supply & Technical Development

Sir, I am happy to be present here today. We had learnt by the second Pakistani aggression created on our soil that there is no foreign aid without strings and secondly there is also not even foreign collaboration without strings. As you know, we are passing through a very critical period. Many of you are not aware that during this present emergency, we were told by the foreign collaborators that they will not collaborate with us in carrying out certain programme until we accepted para 1 of the Resolution of the Security Council. This shows the attitude of the foreigners during our national emergency. It, however, gives us a great lesson to learn. That is, to stand on our own feet and exercise self-reliance on all our needs and requirements. As has been mentioned by the other speakers also, there is a general public demand of foreign goods. Even if you go to the market to buy an article like woollen sweater, the shopkeeper will immediately ejaculate, "here is an imported stuff if you are prepared to pay more". We, therefore, do our best in producing the substitutes to meet such growing needs. While it is necessary that the industry should go to science, it is equally essential on the part of science to go to industry and send their young scientists, technicians, engineers to the big factories, plants and big industrial centres to make an appraisal of the situation on the spot and give their advice and guidance in solving their difficulties. I am fully aware of the fact that chain of national laboratories and research institutes exist in our country. But I would like to draw your kind attention, Sir, that even the scientific organisations must reform themselves to give opportunities to the younger engineers and technicians who are fired with zeal, enthusiasm and are very eager to make their own research contributions. There have been cases where the head of the institution does not want the papers to be published by the juniors. Such narrow approaches should be completely eliminated and a proper climate and temper for science and scientific research should be created.

Variations in the pay scale of our scientists with their counterparts in the foreign countries should be avoided as far as possible. I know that there are many young scientists who are eager to come back to our country after acquiring the necessary training abroad. It is very essential that "job-satisfaction" should be created for these young scientists by our research institutes so that their energies may be utilised fruitfully for the benefit of our country. Something has been done in this direction, but however, there is crying need to do much more if we had to create incentive for our young scientists.

The august body like the present one (Research and Industry Get-Together) should meet from time to time or at least once in a year to assess the progress made in this direction and to ensure that everything was going in a right way. This conference should not be a temporary honeymoon between science and industry but it should be a continued process. There should also be a fruitful follow-up of the work of this conference.

Before I conclude I assure you Mr Chairman that you will get wholehearted cooperation from the Department of Technical Development in promoting scientific research in the country and meeting the challenge that the country may have to face in the coming years. If the scientific organisations work hard, I am certain that the industry will certainly rise to the occasion.

Dr M. S. RANDHAWA

Other members have emphasised that every priority should be given to industry and science but according to me priority should be given to agriculture. Industry must be geared to the services of agriculture. This will make our country achieve self-reliance and self-sufficiency. Of course, we have progressed much in agriculture by adopting modern techniques but ever growing population is hampering its improvement. Chemical fertilisers, large scale agricultural equipment and machineries, oil for farming, plant protection, electricity in agriculture, all these are the essential weapons for agriculture and it is all the more necessary that all the concerned industries must give importance to produce things at lower cost and those equipment, apparatus, must be made available to the Indian farmers at a cheaper rate so that agriculture, the ultimate aim, must be achieved. We should also change our policies in such a manner that import of agricultural products must be curtailed and encouragement is given to the agriculture. At the present moment Indian farmer is not finding the modern agricultural machineries due to their high cost and difficulty to get them easily.

This Get-Together should be given a permanent shape so that annual meetings can be held.

Prof. R. C. MEHROTRA

I am very happy to have been given an opportunity to say something. I am equally conscious of the fact that the time at my disposal is very short. I shall, therefore, be as brief as possible, and try to finish within the limited time at my disposal.

Being a humble teacher and student of science, I can speak from my personal knowledge. Sometimes it is said that scientists do not cooperate with the industry in solving their technical problems. But speaking from my own personal knowledge, I can very well say that some erroneous impression exists in the minds of the industrialists in general. I would like to illustrate one small example to show whether the fault lies on the part of the industrialists or scientists.

In Rajasthan, an industrialist who happens to be known fairly well by the Vice-Chancellor of the University, visited the University. During the course of his visit, he discussed one problem and requested the University to find a solution for it. The University considered the matter and it was felt that the problem could be very well tackled by opening a small laboratory in the University campus and by employing two analysts for this purpose. The industrialist was informed to come forward with the necessary financial help in taking up this work on his behalf. Nothing fruitful has been done so far by the industrialist and the problem hangs where it was. I, therefore, suggest that such hesitation on the part of industry should be avoided.

In the foreign countries, the condition is just the reverse. I happened to visit one firm in USA for purchasing certain equipment. When I contacted the executive concerned, I was told whether I was the same gentleman who had published some article in the Indian Journal of Chemical Research. They gave me all the care and attention and disclosed to me that by adopting the formulae suggested in the journal, they have been able to minimise the complaints of the users of certain particular item to the order of 30 to 40 per cent and they felt very happy over this.

I, therefore, suggest that this type of outlook should be developed by our own industrialists.

University can play a vital role in the national development and also in solving the various problems. It is, however, common knowledge that there still exists some gap between the discovery and the utilisation of results of research. It is very important that this gap should be bridged by the universities. Certain time targets projects should be given to universities for research, as is being done in the Chemical Research Committee of the CSIR.

Dr A. N. GHOSH

On behalf of the Indian Standards Institution and on my own behalf, I wish this Get-Together a grand success.

Cooperation of science and industry is a key role to science. Science and industry should work in close partnership. When the laboratories take up work, the collaboration between industry and laboratory should start from the very beginning. Industry must take its part in financing the different projects with full collaboration and this should be a continuing process.

Major-General J. R. SAMSON

From the defence point of view, industry has been brought together with the research. It is a well-known fact that in normal peace time, the needs of these services (research and industry) for arms, ammunitions, ships, tanks, aeroplanes, and other equipments are not only a small fraction of the needs when engaged in operation. It should be possible only through some Working Groups consisting of defence people and of the civil industries to work out as to which industry has skill in the type. For ammunition, engineering equipment etc., we are working in collaboration with the Directorate General of Supplies and Disposals and Directorate-General of Technical Development. We must make every effort to cut down import of military weapons.

Dr JAL R. PATEL

Government should be more generous regarding finances for the scientific research organisations. Being the Chairman of the Executive Council of Central Drug Research Institute, Lucknow, I know they have produced about 30 new drugs and other several valuable medicines like Plasma, but due to cuts imposed on their budget they could not progress much and they had to drop certain valuable programmes affecting the country as a whole. I recommend the existence of such an institution as the present one which can discuss problems and solve them. In spite of foreign collaboration there should be more collaboration between industry and science to improve the economic conditions in the country.

Shri P. A. NARIELWALA

I am happy to know that there is no financial cut imposed on the budget of scientific research. Money for scientific research should be substantially higher in meeting the challenge that has been imposed on us. Industry has offered that its services are open to the defence to take advantage of the facilities in making the country self-sufficient.

We must restrict our imports and encourage more export to earn foreign exchange.

There must be exchange of technicians and scientists between science and industry to gain more cooperation and skill.

Shri T. N. BANSAL

On behalf of the Indian Chambers of Commerce and Industry and on my own behalf I express my best wishes for the grand success of Get-Together meet.

Scientific knowledge and researches should be made available freely to the industry in solving its day-to-day technical problems. At present there existed some gulf between the technology and technique. We should divert our energies in bridging this gulf. Paucity of funds should not come in the way of research. We must be in a position to spare funds for carrying out scientific research in the country. Situated as we are, we are at the brink of industrial revolution. In other countries various scientific strides have been noticed, and even the space has been pierced. We should not lag behind in this scientific race.

Science is a very vast knowledge. There is inseparable link between science and industry. Science and industry have to get together and think in terms of producing results. We in the CSIR have different pilot projects where the results of research are being tested and handed over to the industry for solving its problems. The industry should approach these national laboratories for the solution of their problems without the slightest hesitation on its part.

I want to assure this august gathering that so far as the Indian Chambers of Commerce and Industry is concerned we shall fully cooperate with the CSIR and put all our sources at its disposal.

Shri S. K. SEN

Sir, exchange of views are always helpful and I would like to say that this Get-Together has brought us very near. I have every hope that positive results will flow from the detailed discussions which we are going to have in this type of conference. We should try to develop our own indigenous sources as far as possible. However, where it is not possible to do so, we might go in foreign technology, plants and equipment to some extent. Our aim should be to spend our financial resources generously on our research. No country in the world has flourished without spending money on its scientific research programmes.

I would, therefore, like to appeal to my industry friends that let us not suffer from this wrong attitude of not spending money on research.

Let us be wise and spend money on research in order to get positive results. Time is the essence of the present situation. We should try to complete our projects as expeditiously as possible and bring home to the industry the results of our research.

SHRI S. G. BARVE

I must congratulate the Minister of Education and the Director-General for organising this Get-Together of Research and Industry. It is for the first time during the last eighteen years that scientists and industrialists are meeting together on a common platform to discuss their mutual problems. It is very happy indeed, though the beginning is too late, however it is very good beginning. I fully share the views of Shri Raghu Ramiah that there will be a periodical Get-Together of this nature. It should not only be a temporary honeymoon of the industry with science but it should be a happy and long marriage, a Hindu marriage, if you like.

The contribution of industry to foreign exchange earnings was negligible. Despite sufficient industrialisation the balance of trade was more unfavourable and in the past there had been operationally a certain amount of failure in allowing collaboration agreements when well-known conclusions reached by scientists were available in government shelves.

While the country must aim at maximum self-reliance it should not mean that India is trying to have an insulated economy. We have all the necessary remedies to remove the difficulties that are being faced by our country. Scientific and technological laboratories can help in this direction. We must give importance and encouragement to swadeshi goods to earn more foreign exchange. Not only necessity is the mother of invention but the necessity is also the mother of determination.

The intention of Get-Together is to bring the partnership between industry and science. The ultimate aim lies on high quality of our scientists and technicians. Our scientists should be able to have free investigations in the laboratories and they must be well-employed but on the other hand scientists should not take undue advantage of the facilities.

Science should be action-oriented and on the other hand industrialists should be research conscious.

SHRI H. K. S. LINDSAY

I am very glad that this imaginative Get-Together on Research and Industry has been organised. Clearly a full scale meeting between scientists and industrialists will be both stimulating and valuable at a time when it has become more necessary than ever before to find substitutes for imports. However, what is not perhaps fully appreciated is the volume and direction of research activity required in relation to the needs of the economy; in this context there are some important basic questions to be answered which I hope the conference will deal with. May I pose some of these and make some suggestions.

First of all, whilst I am delighted that the temptation to cut research expenditure in these critical times has been resisted, the level of research expenditure in India at 0.3 per cent of national income is very low as compared with other countries. The figure in the UK is 2.7 per cent, in the USA 2.9 per cent and in the USSR 3 per cent, i.e. 10 times greater than India's. Though this in a way is a concomitant of the growth these countries have achieved, it is also reasonable to suggest that research is a contributory cause of their growth. Yugoslavia and China have also recognised the connection between research and industrial growth; their per capita investment on research is respectively three and four times that of India. Thus it seems that despite the many calls on our scarce resources, research expenditure in India should be increased very substantially.

Nevertheless, because of the resources position it will not be possible to allocate all that we may like to for research. This makes it essential for research activity to be concentrated on areas where the most rapid results will be achieved. For example, the use of our natural resources for import substitution and for improved productivity in the defence and agricultural sectors.

More Applied Research

While not in any way denigrating the role of pure research—for it is pure research that creates the new industries—the rapid results we strive after indicate higher expenditure on applied research which creates the new things in industry. This does not of course mean that the entire research effort should be harnessed directly to the technological objectives of the economic plan, but that more of it should be directed there to than at present. With our Chairman I would like to see more research effort directed towards the particular needs of industry, more research on an industry-wise basis, as has already been started in the textiles, rubber, paint, plywood, automotive and tea industries, with the larger units—all the larger companies—in the less homogeneous industries organising their own research facilities, possibly in a more limited and concentrated manner.

Design and Development

If bright ideas are not to remain just bright ideas spawned in laboratories and are to be helped to evolve into new and improved products and processes, greater recognition must be given to the problem of introducing design and development functions into the organisation structures of industry. May I make clear what I have in mind. The Research Function in industry is normally devoted to the scientific study of materials, processes and products and to providing the right climate for invention and discovery. Design is an aspect of development: it is the first link in the chain between economic production and invention or discovery, which has to be interpreted through design. Development is the final link between discovery, invention and production : it is the stage of perfecting and testing; the means by which a new product or process is brought to the point where economic production and consumer acceptance are assured.

Although invention and discovery are the *raison d'etre* of a Research Department, they can originate in one or more of a variety of departments of an organisation. An original idea may come from a research worker, a designer, a factory operative, a buyer, a supplier, a salesman, a customer, or even a competitor. It is, therefore, important then that a company should have in it, at least somewhere, a climate in which new ideas about products or processes can flower. The ideas having flowered, it is equally important to have a means whereby they are culled from all sources within the organisation and outside it, interpreted through design, and developed to the point of consumer acceptance and production. This leads to the conclusion that where the scale of operation is large enough Design and Development should be recognised as separate functions of the organisation and integrated as closely as possible with the research laboratories.

Financing Research & Development

A formidable problem is finance, for though the pay-off from money spent on applied research and development is quicker than from pure research, it is essentially a matter of long term perseverance and investment in the future. This must be faced up to by industry and government alike; the former in finding the funds for their research budgets and the Government in enabling and giving encouragement, possibly in two ways: by providing fiscal incentives such as allowing a high rate of development rebate, say 25 per cent, for all research equipment and perhaps finding funds where foreign exchange is absolutely essential. For it is apparent that a number of years will elapse before a full range of scientific equipment is made in India. The example set by the Canadian Government is interesting. Companies whose research and development projects are approved by Government receive up to 50 per cent of expenditure costs from Government funds. These funds are interest free and do not have to be repaid unless the project is commercially successful. To be eligible for Government assistance the projects have to involve new products or processes and represent genuine technical advancement.

Education and Communication

There are problems in the field of scientific education, e.g. how to help the teaching establishments particularly Universities and Technical Colleges to obtain the modern equipment without which their teaching will rapidly become out-dated. There is also the need to include in syllabi training in laboratory administration with the object of improving project planning. Then there is the need for teaching establishments to convince their students of the aims and objects of industrial and scientific research. Too many new entrants consider research purely as an exercise in obtaining information without appreciating that the underlying requirement in industry is to produce economic results. This is perhaps a matter in which industry and the educational authorities should get together: it might be worthwhile producing special 'industrial' lectures at a suitable stage in the academic programme.

On the allied subject of communication there is the problem of achieving closer liaison between the private and the national laboratories particularly on long term projects. Also the means of improving the speed of disseminating new scientific information.

Technology from Abroad

May I conclude by touching on a delicate subject and reiterating what I have said on another platform on the subject of technology from abroad. With India now entering a more sophisticated phase of development, the widest possible access to know-how will be crucial to success. This calls first and foremost for fostering domestic talent and expertise in which confidence has been rather slow to develop and which is the main subject of this conference. Secondly, for a move in the direction of selectivity in relation to the importation of know-how with the specific object of making the fullest use of domestic capabilities. The shift is even otherwise necessary. India's new capital goods industries cannot come into their own without this complementary development. However in this matter, as in so many others, time is not on India's side because of the arrears of growth she has to catch up with. The need for speed will itself require self-reliance. I was, therefore, glad to hear the Chairman infer that some provision should be made for the continuing inflow of knowledge and experience from abroad, especially in those spheres where India's experience is still limited for as Dr Ramaswamy Mudaliar said in Madras a week ago "every nation has something to learn from the other nations......there can be no complete self-sufficiency in knowledge or techniques". In short, if all of us in science and industry are to meet the tremendous challenges of today, to which the Chairman has referred so eloquently, we must remain in the mainstream of world research and development. If we do, the elimination of imported components and the substitution of imported materials which are so vital to the country may be accomplished as rapidly as economic and social imperatives demand.

PROF. V. K. R. V. RAO

I am very glad to have this opportunity to say a few words at the opening session of this Get-Together of scientists and industrialists. In the context of the present acute foreign exchange shortage, created mainly by the uncertainties surrounding external assistance, export promotion on the one hand and import rationalisation and import substitution on the other must be our twin strategies in the field of foreign trade. The task of import rationalisation and import substitution will call for our powers of innovation and improvisation to the utmost. If this is to be done the scientist and research worker in the laboratory and the manufacturer in planning and executing his production programme must come together much more closely and in a more purposive way than they have done in the past if the problem of import substitution is to be tackled effectively. In other words, what the situation demands is a harmonious alliance between the ingenuity and skill of the scientists and the initiative and adaptability of the industrialists. The Council of Scientific & Industrial Research, therefore, deserves to be congratulated for bringing together representatives from these two broad fields of endeavour so that they may jointly apply themselves to the urgent task of evolving a practical programme for import substitution and import saving.

Many of you may be aware that a Committee on Import Rationalisation and Import Substitution was set up under my chairmanship by the Ministry of Commerce towards the middle of this year, following a recommendation of the Board of Trade. The terms and reference of this Committee are as follows:

(a) to review the progress achieved in import substitution during the first three Plans periods and indicate in broad outline the work still remaining to be done;

(b) to consider in detail the type of systematic studies required on the subject of import substitution, with special reference to the replacement of imported goods by acceptable indigenous substitutes; and

(c) to recommend the types of institutions and agencies through which studies could best be undertaken.

Following its first meeting in July 1965, the Committee invited the views of important industries/associations/agencies and departments in the form of Memoranda on the terms of reference of the Committee. In response to this request the Committee has so far received memoranda from a large number of organisations and individuals. Apart from its own meetings, the Committee has held discussions on the subject of import rationalisation and import substitution with the representatives of various industrial and trading organisations in Calcutta and Bombay.

From the evidence received by the Committee, it is clear that while appreciable progress has been made in the last 15 years in regard to import substitution in the country, the problem of import substitution has not yet been tackled in a comprehensive and scientific manner and that there is a large scope for import rationalisation and import substitution in various directions. A number of suggestions have been received by the Committee from various industrial and trading organisations for achieving import substitution which I hope to make available to Director-General for circulation to the Institutes and Scientists concerned.

Here I would like to refer to some of the general aspects of the problem of import substitution and import rationalisation. A first task in dealing with this problem is to make a proper assessment of the present import content of various industries, including in this not only the direct imports of the industry but also the import content of what they purchase from other domestic producers, which may be called 'indirect imports'. Secondly, imports of materials and equipment can be replaced not only by the production of identical items in the country, but where the identical product cannot be manufactured, by what may be called 'functional substitutes'. Substitution by the latter method would require further technical and scientific research in the country. Thirdly—and this is a point which has been made several times before the Committee—significant import substitution can be achieved through the standardisation of designs, particularly of components and parts. There are a number of instances where components serving the same functional purpose are used in a multiplicity of designs or specifications. If such parts and components can be standardised into a few varieties and industrial users persuaded to use only such varieties, domestic production can be undertaken economically and imports of such parts and components reduced or avoided altogether. Fourthly, import saving can also be achieved through what may be called *process* substitution. Well-known examples of such substitution are the aluminisation of transmission towers instead of galvanisation, the use of the electrolytic process in tin plating instead of the dipping process, etc. Fifthly, an important aspect of the problem of import saving is the rationalisation of the use of imports. Import saving can be achieved through the substitution of semi-finished products in place of finished products or of raw materials in place of semi-finished and intermediate products.

Finally, it follows as a corollary from the need for technical and scientific research into the problems of substitution that there should be adequate and fruitful liaison between research establishments on the one hand and industrial enterprises whether in the public or in the private sector on the other. From the observations made by various representatives of industry and trade it appears there is no adequate liaison at present between national laboratories and institutes and manufacturers on the subject of import substitution. Domestic manufacturers do not often know what kind of research is being pursued in the national laboratories nor do the national laboratories know what concrete practical problems are being faced by manufacturers in the country.

I come now to some of the suggestions relating to individual industries that have been made before the Committee on Import Substitution. Chemicals and commodities based on chemicals constitute one of the major elements in our import bill. In 1964-65, imports of chemicals amounted to Rs 38.4 crores, dyeing, tanning and colouring materials to Rs 9.3 crores, medicinal and pharmaceutical products to Rs 8.3 crores, fertilisers including crude and manufactured to Rs 26.2 crores. In addition, imports of sulphur as a raw material were of the order of Rs 5.4 crores in 1964-65. Sulphur and rock phosphate are the basic chemicals for the fertiliser industry as also for a number of other chemical industries. Two suggestions have been made for economising the use of sulphur, viz. the possibility of substituting ammonia for sulphur in the fertiliser industry, and the substitution of hydrochloric acid for sulphuric acid in the steel industry. Another way of saving on imports of sulphur would be to use pyrites as a substitute for sulphur. In this context, the urgency for the early commissioning of the pyrites project in the public sector has been emphasised. Another suggestion made is that in view of the world-wide shortage of sulphur and rock phosphate, it will be worthwhile for Indian businessmen to go in for investigation and exploration of deposits of these minerals abroad. Since there is an element of risk arising from political uncertainties in the future, it has been urged that some means should be found for securing entrepreneurs against such risks. As for the dyestuff industry, it has been suggested that the outlay on imports can be reduced considerably if instead of finished dyestuffs, intermediates are imported. Further saving can be achieved by reducing the number of different types of dyestuffs that are being imported, for if a particular shade is not available this can be easily substituted by another or a mixture of shades. For the production of intermediates for the dyestuff industry, the speedy implementation of the Hindustan Organic Chemical has been urged. Again, in regard to the paint industry, it has been represented that if the Defence Ministry and the DGTD could revise ther specifications regarding paints, as was done in the Second World War, this would lead to a substantial saving in imports.

In the case of drugs and pharmaceuticals, it has been represented by the industry that it is in a position to manufacture most of the medicinal and pharmaceutical products provided sufficient raw materials are made available. This is specially true in the case of certain preparations like sulphonamides, caffine, sera, chloroquine, dichloroquinoline, isoniazide, etc.

The plastic industry which started production in the post-war period with imported raw materials is now in a position to produce indigenously important raw materials such as, phenol formaldehyde moulding powder, and thermoplastic moulding powders. The industry is, however, still dependent on imports for a number of items. It has been stated by the representatives of this industry that if instead of cellulose nitrate, polymer and plasticisers are imported and compounded in the country, a considerable saving of foreign exchange can be achieved. Again the plastic industry can make a significant contribution to the saving of non-ferrous metals, such as brass, copper, tin, etc. Thus to give a few examples, savings can be effected through the use of plastic buckets for G.I. buckets, PVC and polyethylene for cables instead of lead, the use of polyethylene for drinking water pipes up to 4", and the use of plastic containers instead of tin plate containers.

The group of metals is another major element in our import bill. In 1964-65, imports of iron and steel amounted to Rs 107.4 crores and of non-ferrous metals to Rs 58.3 crores. Concentrated attention must be devoted to both these groups of metals from the point of view of import substitution. While over the years we have been able to increase substantially the production of mild steels in the country, we are still largely dependent on imports for our requirements of special steels both for civilian and defence purposes. Since special steels are much more costly than mild steels, success in producing these types of steel would result in substantial savings in foreign exchange. It has been pointed out by the representatives of steel enterprises in the public sector that it should be possible to vary the production pattern in the public sector steel plants so as to produce certain quantities of special steels, although this will involve a small decline in the total tonnage of steel produced. Thus if the Bhilai Steel Plant can produce high carbon billets, these can be rolled by indigenous rolling mills and imports of high carbon wire rods thereby be considerably reduced. Similarly, if one of the steel plants could produce free cutting quality billets and these were rolled by mills, indigenously produced free cutting quality billets could be made available to industries in India in place of imported billets. This is thus an important area of possible import substitution which needs to be examined and explored very carefully.

In speaking of process substitution earlier, I have given two examples whereby savings can be effected in the use of non-ferrous metals, such as, copper and tin. There must be many other ways or processes by which savings can be effected in the use of non-ferrous metals. This is another area in which innovation and improvisation on the part of the scientists and ndustrialists will yield worthwhile results.

Finally, there is the wide and diversified field of machinery and component manufacture. While it may not be possible at present to manufacture whole machines or equipment for a number of industries, it should be feasible for us progressively to raise the percentage of domestic components in whole machines and equipment. For this purpose, the machinery requirements of the various industries should be studied in great detail, identifying sections or components that can be produced in the country with indigenous raw materials or if the need be even with imported materials. Secondly, it would be necessary through design offices and standard institutes to standardise plant sizes and components of machines. When the multiplicity of designs that prevail today in various industries are reduced to a few standard specifications, production on an economic scale can be undertaken in the country. What is more, with standardisation, it should be possible to call in the services of the small scale industrial sector to supplement production in the large scale sector. This may lead to economies in the cost of production. Thirdly, efforts should be made by machine-making industries to take the working drawings of machinery, components and accessories from foreign manufacturers so that through imitation or improvisation components and accessories may be produced within the country. I have referred to some of the general problems which have to be tackled in regard to the manufacture of machinery and equipment, and do not wish to go into the problems of individual machine-making industries. Such specific problems can be discussed fruitfully by the different working groups into which the Conference will divide itself.

Key Papers

MEETING OF WORKING GROUP 1

1. Electronics, Instruments, Radio, Television Public Address Systems

Introduction

The response to the invitation from the CSIR for participation in the 'Get-Together' for Research and Industry has been very encouraging. This is indeed a hopeful sign and portends well for further cooperation between research and industry.

The present keynote paper prepared by the Convening Committee of the Working Group is an attempt to highlight the points which have been made in other papers and to bring out the trend of thought for further discussion leading to conclusions and recommendations.

General Approach

A line of thought which appears in practically all papers that have been received is one that emphasises the paramount need of cooperation between users, industry and research organisations, in achieving self-sustaining growth.

Another thought expressed in several papers is the need to choose a few problems to begin with, which have a high priority. In this way, the work can get started and more and more projects could be added as time goes on.

In certain papers stress has been laid on need for training additional personnel in specialised skills which are now available with only a handful of people.

Background of Requirements

The Bhabha Committee has assessed the country's requirements during the ten year period at Rs 16,000 million, out of which the requirements of the defence sector alone constitute about Rs 7,800 million. The total demand for radio receivers and consumer electronics is likely to exceed Rs 3,200 million.

Balanced Growth of Industry

The size of the existing Electronic industry is rather small compared to the gigantic task ahead. For achieving near self-sufficiency in Electronics, it would be necessary to augment the production capacity by Rs 300 million every year during the next decade. This will ensure an annual production capacity of Rs 3,300 million at the end of the next ten years. For balanced growth of the industry, it would be essential to commit the effort to the following sectors in a rational manner: (i) Raw materials, components and accessories; (ii) Industrial instrumentation and control; (iii) Broadcasting and television equipment and radio and television receivers; (iv) Electronic computers and data processing systems;

(v) Electronic instruments; (vi) Communication systems; and (vii) Microwave systems.

Capital Investment

In terms of capital investment, a total sum of Rs 1,800 million will have to be invested in the industry during the next ten years, roughly at the rate of Rs 180 million per year. It is, of course, clear that neither the investment nor the production will increase on a straight line basis but this rough assumption would suffice to provide an order of magnitude of the development programme.

The break-up of estimated capital investment and annual turnover for different sectors of the Electronics industry is given in Table 1.

Scope of Electronics Industry and Research

Broadly speaking, the area of the requirements of industry and research can be divided into the following groups:

(a) Equipment and Systems, (b) Component Units, (c) Components, (d) Raw Materials.

Table 1—Estimated Capital Investment and Annual Turnover of the Electronics Industry

Sl. No.	Item	Estimated annual turnover required at the end of ten years	Estimated capital investment
		(Rs in millions)	
1.	Raw materials*	240	120
2.	Components*	840	410
3.	Radio receivers and other consumer products	900	250
4.	Communication systems (radio and line communication)	620	260
5.	Microwave systems and associated equipment including radar and radio-navigational aids	580	250
6.	High power radio transmitters, industrial heating equipment, railway signalling and process control installations and other major industrial equipment	500	200
7.	Electronic equipment for line communication systems	300	130
8.	Computing, data processing and nuclear, medical and industrial equipment	330	150
9.	Test instruments	70	30
	TOTAL	3,300	1,800

*The value of raw materials and components (items 1 and 2) has been taken into account in the final cost of equipment in items 3 to 9.

In order to achieve practical results, the requirements under each of the above heads include the following:

(a) Financial viability for the industry and financial viability for the required capacities in each of the areas in the industry
(b) Technical and technological know-how
(c) Applied research and development

While examining the several aspects concerning these, the important considerations to be kept are:

(i) the costs of the equipment produced
(ii) the amount of foreign exchange that is saved
(iii) the essentiality other than from the financial one for producing the particular item in the earlier stages of the programme

The following paragraphs cover each of these separately and also deal with the advantages and disadvantages of indigenous know-how and of foreign collaboration.

Equipment and Systems

What is required by the user is for equipment and systems which are in a completely useful form for meeting his requirements ? A rough distribution of the different types of equipment and systems in the advanced countries is readily available from published information. Instruments and instrument systems are also covered in this group.

The production of equipment and systems in the country has maximum advantages even without the production of the other items, viz. components, etc. The maximum savings from the foreign exchange point of view in establishing the production of the systems alone vary from 75 per cent for entertainment products to about 95 per cent for sophisticated advanced systems, the average being about 85 per cent for the whole electronic industry. The production of system is easily established and the investments required are small and production can be realised in the quickest possible time. The setting up of the systems manufacture also stimulates the setting up of the other intermediate and basic electronic industries, viz. manufacture of component units, components, processing of electronic raw materials, etc.

With the rapid advance in the systems concepts and the changing requirements, it is very difficult to obtain foreign collaboration for systems, since systems based on proven manufacture and use are outmoded by the time they are produced in India. Under properly established conditions, it is the experience in India that design and production of systems can be achieved in about the same period as of equipment deliveries from abroad, if action is taken to get indigenous production established from the planning stage onwards.

As far as the rupee costs are involved, manufacture of systems is competitive to the imported equipment and it is possible to alter the designs and upgrade them as new techniques and components arrive.

Systems manufacture involves a very detailed knowledge and appreciation of the user requirements. The performance or user specifications have to be broken into component unit specifications, and in most cases, established components and circuit assemblies (except in the earliest stages of development in a country) will enable the systems to be built up for use quickly and effectively. The manufacture and processes involved are such that these can be done by small groups of qualified and knowledgeable personnel. The machinery and fixed capital required are small, since it consists of mostly test instruments and of assembly and testing operations.

The know-how for this is best obtained from an advanced specialist section in the user organisation or by specialist research and development organisations oriented to one group of equipment.

Component Units and Sub-assemblies

By 'Component Units' is meant items like transformers, coils, condenser assemblies, printed circuit boards and certain basic circuit modules, power supplies, etc. as well as drives, dials, mechanical panels and modules, boxes, mounting racks, connectors, wire-harnesses, etc.

The availability of these units is not as important in large scale manufacturers of a few items of equipment as for small scale manufacturers. The ready availability of component units is of the greatest importance to complete designs and produce equipment economically and quickly. Manufacture of these items require design knowledge and of manufacturing machines, tools, and processes which are not usually available except with large manufacturers. However, there is considerable scope for some items being taken up separately by specialist designers and manufacturers. If properly organised with coordination and publicity, the establishment of manufacture and sale of these items is easy. The importance of ready availability of most of the generally required component units should not be underestimated. In fact, without such availability, the country cannot undertake the production of the variety of items of electronic equipment required in the country. The techniques and the knowledge required for building the component units is already fully available in the country, even though the component units as such are not available yet. Certain circuit designs also require upgrading and standardisation to permit use in a flexible manner for a variety of applications. The establishment of the component units industry is the key to the rapid development of electronic systems and makes possible great individual initiative in building and supplying of equipment by small groups of knowledgeable persons. This is the way in which other countries have advanced in Electronics. The manufacture of these requires a certain amount of work of standardisation, or by adopting the popular foreign component units as a starting point. The manufacture of the different units calls for different production techniques, some of these completely mechanical engineering in nature (including much of microwave component units) and others like circuit modules calling for electronic research, design and know-how. It is best to examine each item and with specialist groups handling each item the production at reasonable costs become practicable. The machinery, capital investiments as well as the know-how can be planned so as not to require more than the minimum redundancy.

The Electronics research groups should develop and improve continuously the circuits required as building blocks of systems and mechanical engineering groups evolve continuously the large amount of hardware at economical costs. The manufacture of these items is possible in a large number of cases in the small scale sector.

Components

The importance of components in the Electronics industry is too well known to be emphasised. The variety of components that is used in the advanced countries like America are fully listed and the relative total values are also given therein. With the exception of America and perhaps Russia, probably no other country manufactures them in full range. The manufacture of components generally required in large quantities, is a prerequisite for our becoming self-reliant

While the manufacture of the components in the country is very important from the point of view of self-reliance, the foreign exchange savings as a percentage of the total equipment costs by manufacture of the components in the country is not large. As stated elsewhere, the total value of the components in the average equipment is about 15 per cent of the cost of the total equipment.

For establishing a good Electronics industry, it is vital that the costs of components are kept very low (and especially so in the entertainment field, where the components account for 25 per cent of the costs). In other countries, the most sophisticated and modern methods are used for the manufacture of components leading to very low unit costs. The success of Japan and America in the entertainment electronic fields is based on large availability of components at very low prices. The types to be chosen for manufacture and the processes to be used should be directed to highlight this aspect. The other vital aspect is that components made must be stable and reliable. These should be established conclusively before these are used in electronic systems. The know-how for the manufacture of components is comparatively of an evolving nature; revolutionary developments as in the case of systems are few. Even modern devices such as transistors and integrated services have now reached the evolutionary stage and have passed from the evolutionary stage. The know-how that is required in the manufacture of components is not one of Electronics in nature but of machine design involving production engineering and of a process suited to such production. The processes in themselves are not complicated. The research, development and know-how required, therefore, are essentially in the design of machinery and choosing the right processes to give a higher output of quality components at low costs. Continuous long term and short term testing of samples is a prerequisite to establish the required degree of confidence.

Raw Materials

The materials required for the production of electronic components fall into several areas of materials technology and metallurgy. The foreign exchange reduction by the use of indigenous materials is a very small part of the total systems cost, since this is a small part of the components cost. The importance of finding and using indigenous raw materials is based on self-reliance.

It should be emphasised that, as in other countries, we cannot reach 100 per cent self-sufficiency and we should attempt to view each item and take it up for manufacture and research.

Selection of Tasks

It is seen from the above that scope for work is indeed very great in respect of materials, components, instruments, as well as finished systems.

It is necessary to pick out specific tasks which can be completed in relatively short time.

The high priority projects can be called from the papers which have been submitted, as well as the data that have been collected by the Electronics Committee. Broadly speaking, the tasks can be classified under the following headings:

I. Primary Materials
II. Electronic Components
III. Instruments:
  1. Optical
  2. Electronic
  3. Industrial:
    (i) Geophysical and Civil Works
    (ii) Electromedical
    (iii) Data Systems
IV. Equipment Modules
V. Systems

Means of Implementing Recommendations

It is visualised that the following steps will have to be taken after the tasks have been selected by the Working Group:

1. Exact specifications must be drawn up for each of the projects.
2. The development of the different products could be sponsored either with the Government laboratories or with those units of the industry that are willing to do developmental work on a contract basis.
3. A mechanism must be set up for follow up action in connection with progress on the different tasks, making payments, arranging transfer of know-how, etc.

Conclusion

A well directed and coordinated effort between research, industry and the users is the key to the establishment of the Electronics industry. The role of each varies, depending on the item involved and the elements to be taken into account for making the programme a success. The aim should be to set up the industry in a manner so that it can expand rapidly. Cent per cent self-sufficiency is neither practical nor desirable and should not have more than its share of importance, whether in industry or in know-how. A properly drawn up priority in industry as well as in research would expedite the setting up of the industry and savings of foreign exchange.

NAME OF COMPANY/ORGANIZATION

Main Heading Pl. put a square mark against appropriate item	Items (Pl. List)	Areas of Laboratory Development			Capabilities of Prototype Development			Production			Main Import or Requirements	
		Already done	In progress	Willing to do	Already done	In progress	Willing to do	Already done	In progress	Willing to do	Item	Value
Raw materials	…………………… …………………… …………………… ……………………	☐	☐	☐	☐	☐	☐	☐	☐	☐		
Components	…………………… …………………… …………………… ……………………											
Modules and Circuits	…………………… …………………… …………………… ……………………											
Instruments	…………………… …………………… …………………… ……………………											
Other Equipment	…………………… ……………………											

2. Industrial Organic Chemicals, Biochemicals, Dyes and Intermediates, Rubber, Resins, Adhesives Plastics, Paints, Varnishes, Surface Coatings

Introduction

Recently the CSIR has directed all its laboratories to devote most of their research effort to the following topics in order of priority:

(1) Defence effort

(2) Import substitution/elimination

(3) Export promotion

(4) Food production needs

Whereas a close liaison has been established with the Defence authorities for defence needs and the topmost priority is being given to such problems, it is necessary that the CSIR gets in touch with industry in order to carry out useful work aimed at objectives (2) & (3) above. The closer the two get together, the better are the chances of the work of the laboratories being utilised by industry as soon as it has reached the pilot plant stage.

The CSIR is therefore continuously striving to associate industrialists and their scientific and technical personnel with its activities. Thus scientists and technologists from industry as also industrialists have been invited to serve on the CSIR policy making bodies such as the B.S.I.R., the Governing Body, Working Group on CSIR plans, and Executive Council of individual laboratories. In addition, recently technologists from industry have been further associated with the advisory panels of the CSIR laboratories. Through these advisory panels the research programmes of the laboratories are being continuously assessed for their practical application and evaluation. The panels have also helped the laboratories in research-programming.

Also recently the Indian Chemical Manufacturer's Association and the CSIR have established a Liaison Centre in Bombay with the view to foster close contact between the chemistry-oriented CSIR laboratories and the chemical industry. It is hoped that the Liaison Centre will prove useful to CSIR scientists as well as to industry since it will provide a forum for discussion of the developments in chemical science and technology which could be of use to industry in solving both their short-term and long-range needs in chemical technology.

Whereas the steps taken by the CSIR outlined above are all to the good, the recent conflict with Pakistan and the continuous threatening

WORKING GROUP 2 IN SESSION

posture adopted by China have necessitated another and more vigorous approach aimed at making the CSIR laboratories play an even more effective role than hitherto in providing assistance to industry to enable it to become increasingly self-reliant both for its current activities as well as for its future development. The present 'get-together', it is hoped, will lead to concrete proposals for an all out effort for undertaking a research programme aimed at reaching the CSIR objectives outlined at the beginning of this paper.

An attempt is made in this paper to spell out the major specific problems which need to be tackled and also to indicate, wherever possible, the priorities for undertaking developmental research in these topics.

Relevant Issues regarding Development and Utilisation of Indigenous Know-how

Some of the related problems, such as the need or otherwise of foreign collaboration in solving specific problems may also be discussed. Some participants of this working group have made useful suggestions as regards desirability or otherwise of the question of getting foreign know-how.

Another important point is the need to have a rational policy as regards the tariffs on imported raw materials. Specific proposals on the need to have a graded induction of import duties on raw materials depending on their chemical complexity will be discussed later while discussing problems of the dyestuff industry.

It may also be useful to discuss the particular industries which could undertake production of the presently imported raw materials in the near future. The presence of representatives of the major organic chemical industries may be taken advantage of in finding out industries which could be prepared to sponsor work on development of know-how for the imported products.

Sponsored Research a Key to Self-reliance

One of the quickest and probably the most efficient ways to develop know-how indigenously is by carrying out the developmental work either in the research laboratories of industries themselves or by the CSIR and other laboratories in the country as projects sponsored by industry. This is particularly true and feasible for established industries (especially in the organised sector) who have already accumulated considerable know-how and background information for such projects often through foreign collaboration. Since these industries have installed manufacturing capacity, translation of a laboratory or pilot plant process into a full scale unit will be easier in these units. The scientists in the research laboratories, on the other hand, could tremendously benefit by close contacts with their counterparts in industry in case the projects are sponsored by industry. The research effort in such sponsored work is likely to be most productive since it will be always carried out against a background of practical consideration and further the sponsoring industry would be serious in utilising the know-how thus developed as it has paid for it.

It is therefore our view that the industrialists who have come for this Get-Together should not think only in terms of spelling out problems for National Laboratories to work on, but should also actively sponsor such research and thus work in very close cooperation with the CSIR laboratories. Indeed quite a lot of information which will now be presented as regards the items which are being imported and which need to be manufactured in India is already known to the users of these products. However, what is really required is follow-up action to solve the problems. It is strongly hoped that this Get-Together will lead to such follow-up action. Sponsored research appears to be one of the most effective ways of taking such follow-up action. It also seems very necessary that certain incentives should be offered to those industries who are progressive and who are inclined to support indigenous research both in their own factory premises as well as in the CSIR laboratories.

Scale up of Pilot Plant Know-how to a Turn-key Job

The CSIR laboratories are now in a position to offer know-how on a turn-key job basis by having their know-how engineered by project engineering firms (this has been done for example for HOC tenders) and by the CSIR Design Unit. Adequate guarantees are also offered. The industries and the relevant Govt of India authorities, therefore, should not harp on the oft-repeated charge of inadequacy of know-how offered by CSIR laboratories. That the projects are engineered on the basis of pilot plant studies and not on large scale manufacturing experience of full scale plants should not come in the way of utilisation of such know-how since this situation is unavoidable until in each case the first commercial unit is established. A developing country like ours must learn to live with this situation and make the best of it.

Barring industrial complexes involving integrated manufacturing operations and large investments such as petrochemical complexes, a considerable portion of industrial processes consist of independent unit operations and processes which may often be carried out batchwise. In the latter cases the risk factor is limited and can be easily foreseen. It is in this sector, that Indian science and technology will be able to play a distinctive role. In particular the Public Sector undertakings should give a lead in making use of Indian know-how based on pilot plant data especially if it is engineered by project engineering firms who are willing to offer guarantees as regards yields, efficiencies, etc. If the Govt of India fails to direct the management of Public Sector undertakings to accept such guarantees as they do from foreign firms and on equal terms, it will be failing in its duty in implementing its own "Technological Swaraj" policy ! This policy will remain an empty slogan and a catch phase if bureaucrats in Public Sector undertakings are permitted to sabotage it by insisting on impossible guarantees based on full scale plants from such project engineering firms as are bold and patriotic enough to engineer know-how based on pilot plant data.

If the Govt of India itself is not serious about implementing its "Technological Swaraj" policy—as is revealed by the recent Parliamentary Committee on the subject—how can it expect the private sector to prefer Indian know-how to foreign know-how?

Need for Incentives for Entrepreneurs who will be using Indigenous Know-how

Mr Shivanand Shah in his comments has analysed some of the reasons why Indian entrepreneurs are inclined to look for foreign collaboration. In the light of these reasons he has strongly urged that the Government should consider providing several incentives for the Indian entrepreneurs who would be using indigenous know-how. Among the incentives suggested are assistance in finance, import of equipment and raw materials that are absolutely necessary, and a guarantee that, for the same products, foreign collaboration would not be permitted. It is hoped that the Working Group will give serious consideration to these very important suggestions which appear necessary if the industrialists are to develop or sponsor indigenous know-how.

Order of Priorities

Since one of the major objects of this get-together is to indicate the order of priorities for tackling import substitution problems, it may be pertinent for this gathering to ask the basis on which such priorities may be arrived at. Considering the critical foreign exchange situation these priorities have to be based on the needs of defence, exports, national health, food production, essential utilities, etc. and it may be necessary to give a lower order of priority to all other products which are not required for the above purposes. Wherever reasonable substitutes requiring little or no foreign exchange are already being manufactured in India, it would be pertinent to ask whether it would be rational to encourage production of other similar items which will require greater foreign exchange and/or will involve foreign collaboration. These questions are particularly pertinent to the dyestuff industry which could do without further development of capacity for additional dyes especially if it is to be realised with foreign collaboration and expenditure of foreign exchange.

Need for a Statutory Provision for Research Expenditure

In view of the magnitude of research effort which has to be undertaken in the coming years for achieving self-sufficiency and self-reliance and the very low order of investment in research by industry at present, this group recommends that a statutory provision (such as that for depreciation and reserves) up to 5 per cent of turnover be made for research and development for all industries in the organised sector. A suitable provision for tax relief on such research expenditure should be granted. Such a provision will lead to a considerable incentive spurt in our research effort both in industries as well as in Universities and CSIR laboratories.

It is pertinent here to emphasise that the major effort for developing know-how indigenously will have really to come from industries themselves. Even if all the CSIR laboratories are fully engaged on sponsored work on behalf of industry still they will be able to solve only a small fraction of the problems that industries may have to face and solve. It is against this background that the above suggestion of a statutory provision of research is made.

After this somewhat lengthy introduction setting out the rationale of this Get-Together and the background issues involved which this gathering may profitably discuss, the specific problems of the various organic chemical industries under the purview of this Working Group will be discussed in the following pages. The Convener has made liberal use of the data afforded by the various participants who have taken the trouble to send very useful papers. The papers have been circulated and a summary of their main points is also attached to this key paper (Appendix). This summary is incomplete since only such papers as were received when this key paper was written have been summarised.

The comments on the various organic chemical industries that follow have been largely based on data submitted by Shri S. J. Shah (Dyes and Intermediates) Shri D. M. Trivedi (Rubber, Resins, Adhesives & Plastics), Prof. N. R. Kamath (Paints, Varnishes & Surface Coatings), Dr C. J. Dadachanji (Industrial Organic Chemicals) and the Convener (Miscellaneous Organic Chemicals). A few papers which are considered to be of more wider interest are also reported here.

Acknowledgement

The Convener is deeply indebted to the various participants who have submitted papers at this Get-Together, the members of the Committee referred to above for their active cooperation, and also to Shri J. V. Rajan and Shri Kulkarni for valuable assistance in preparing this key paper.

DYES AND INTERMEDIATES

The Indian dyestuff industry to-day is producing a total of 272 dyes belonging to almost all the important classes of dyes. Most of the bread and butter dyes required in large quantities are already being produced. The annual indigenous production is 8700 tons valued at Rs 20 crores, whereas imports amount to 1900 tons valued at Rs 4.40 crores.

It will be seen from Table 1 that the country has surplus capacity for production of almost all groups of dyes. The present capacity appears to be even in excess of 1970-71 targets. Only disperse dyes belonging to the anthraquinone group for newer fibres need still to be produced. Apart from these and a few speciality products, India is largely self-sufficient in its requirement of dyes. Those dyes which are not being produced in India at present may not be imported as their import will not be justifiable on the essentiality criteria enunciated earlier in the paper. If they are necessary for exportable items and/or defence, then they may be permitted to be imported by actual users provided they cannot be substituted by near Indian equivalents. In the case of defence requirements also (Table 2), it may be necessary to look into defence specifications for the dyes not already manufactured in the country and see if these cannot be based on indigenous production instead of on B.S.I. standards and British production as at present.

Apart from the dyes whose import is essential for defence and/or exportable items, all other dyes irrespective of their present user and consumer preference (on grounds of fastness, preference in shades, etc.) should be entirely banned and the country must learn to do without them. In case indigenous production of these items is to be considered, it may only be permitted if it is based almost entirely on local raw materials and if very little or no commitment of foreign exchange or know-how is involved.

Indigenous production of dyes is unfortunately based mostly on imported intermediates. Total annual imports of intermediates are valued approximately at Rs 5 crores. It is in the field of manufacture of intermediates, therefore, that the country is lagging behind and considerable progress needs to be made. To some extent this position is due to the delay in establishment of production of bulk organic intermediates in the HOC public sector undertaking (Table 3). It is hoped that the HOC will go soon into production. Not only the dyestuff but several other industries are dependent for their progress on the establishment of production by HOC. Several firms in the private sector are also

Table 1—Dyestuffs : Targets, Capacities and Production in Organised Sector

Sl. No.	Dye group	Target for 1965-66	Estimates of requirement by 1970-71	Capacty licensed as on 1-4-64				1964 Jan.-Sept.
				Already installed	Under installation	Not yet covered by C.G. licences	Total	
1.	Acids and Directs	3,000	3,500	1,653	2,528	—	4,181	780
2.	Basic Dyes	909	800	387	694	—	1,081	195
3.	Naphthols	1,273	1,500	1,273	—	—	1,273	608
4.	Fast Colour Bases	1,273	1,250	863	410	—	1,273	328
5.	Vat Dyes	1,273	1,800	740	339	371	1,450	560
6.	Sulphur Black	2,273	1,500	2,290	—	—	2,290	1,094
7.	Other Sulphur Dyes	227	250	227	—	—	227	34
8.	Organic Pigments	1,182	1,200	905	824	—	1,729	353
9.	Optical Bleaching Agents	—	1,000	332	90	—	422	227
10.	Reactive Dyes	—	500	50	229	—	279	20
11.	Food Colour	—	—	—	213	—	213	—
12.	Alcians and others	—	1,000	—	196	—	190	—
	TOTAL	11,364	14,300	8,720	5,523	371	14,614	4,199

Table 2—Important Dyestuffs Required for Processing Defence Stores

Sl. No.	Dyestuffs	Colour Index No.	Indigenous manufacturer
(1)	(2)	(3)	(4)
1.	Vat Olive R Powder end Micro Disperse	69005	IDI
2.	Vat Olive Green B Powder & Micro Disperse	69500	IDI, ATIC ARL
3.	Vat Olive D or T Powder Fine	69525	ATIC
4.	Vat Brown BR Powder and Micro Disperse	70800	
5.	Vat Brown G Powder and Micro Disperse	73410	ARL
6.	Vat Khaki 2G Powder Fine	71050	
7.	Vat Yellow GC Powder	56005	ARL
8.	Vat Golden Orange 3C Powder and Micro Disperse	69025	
9.	Vat Orange 6R		
10.	Vat Black AC Powder and Micro Disperse	65230	ATIC, IDI

Contd

Table 2—*Contd*

(1)	(2)	(3)	(4)
11.	Vat Blue BC Powder and Micro Disperse	69815	IDI can manufacture
12.	Vat Green FFB Powder and Micro Disperse	59825	IDI, ATIC
13.	Vat Green 2G Powder and Micro Disperse	59830	IDI, ATIC
14.	Vat Dark Blue BO Powder	59800	IDI
15.	Thional Brown GDR	53055	
16.	Sulphur Yellow (Sulphur yellow 2G)	53160	Ind-Dye
17.	Sulphur Navy Blue	53440	Atul, Idco
18.	Sulphur Khaki		
19.	Thional Direct Blue 2RL		
20.	Sulphur Black	53185	Atul, H&D
21.	Scarlet, Orange, and Maroon Shades from Napthal Combinations		
22.	Pigments to produce Olive Green Shade by Printing		
23.	Neolan Yellow BE	19010	
24.	Neolan Blue 2G	15050	Atul
25.	Neolan Yellow GR	13900	Atul
26.	Neolan Orange G	18745	Atul
27.	Neolan Violet Brown B	15685	Atul
28.	Neolan Bordeaux RM	C.I. Acid Red 194	
29.	Neolan Brown GR		
30.	Neolan Pink B	C.I. Acid Red 191	
31.	Neolan Navy Blue 2RLB	C.I. Acid Blue 157	
32.	Neolan Black		
33.	Neolan Green BL	13425	
34.	Neolan Red BRE	18800	
35.	Irgalon Grey BL	C.I. Acid Black 58	
36.	Irgalan Olive GL	C.I. Acid Black 64	
37.	Irgalan Yellow GL	C.I. Acid Yellow 114	
38.	Irgalan Orange RL	C.I. Acid Orange 86	
39.	Lanasyn Black A		
40.	Lanasyn Brown RL	C.I. Acid Brown 28	
41.	Solway Blue BN	60010	
42.	Solway Brown G	61570	
43.	Solochrome Blue Black B		

Contd

TABLE 2—*Contd*

(1)	(2)	(3)	(4)
44.	Solochrome Brown EB	20110	Sandoz, KCA Indchem
45.	Solochrome Yellow 2 GNS	14045	Atul, Indchem
46.	Commassie Navy Blue 2RN	26360	
47.	Commassie Brill Blue FF	42645	
48.	Carbolan Crimson BS	Unindexed	
49.	Carbolan Green G	61580	
50.	Carbolan Green 5G	Unindexed	
51.	Chrom Black PV	Unindexed	
52.	Union Colours required for the production of Khaki and Olive Shades		

Table 3—List of Intermediates in HOC Programme

	Product	Tons/annum
1.	Caustic soda/chlorine (mercury cells)	11,550 (100% NaOH basis)
2.	Sulphuric acid/oleum	33,000 (98% H_2SO_4 basis)
3.	Formaldehyde	15,000 (as 37% solution)
4.	Benzene hexachloride (12% or more γ-isomer)	3,000
5.	Monochlorobenzene	3,500
	o-Dichlorobenzene	300
	p-Dichlorobenzene	600
6.	Acetanilide	2,000
7.	β-Naphthol	1,000
8.	Aluminium chloride	3,000
9.	Anthraquinones, incl. chloro and methyl derivatives	1,300
10.	Nitric acid	16,500 (98% HNO_3)
11.	Nitrobenzene	11,000
	Aniline	6,000
	o-Nitrotoluene	1,900
	p-Nitrotoluene	950
	m-Nitrotoluene	90
	Dinitrobenzene	350
	o-Nitrochlorobenzene	760
	p-Nitrochlorobenzene	1,520
	Dinitrochlorobenzene	1,500
12.	Nitrobenzene sulphonic acid	2,250
	Metanilic acid	1,800
	m-Aminophenol	750
	p-Aminosalicylic acid	200 (as sodium salt)

manufacturing intermediates in ever increasing amounts and variety (Tables 4 and 5).

For some intermediates (Table 6) there are no plans yet for indigenous production. Top priority in research and development of these products should be given. Although the requirements of individual items in this list may be rather small for economic production, taken together and if manufactured in an integrated manner in a multipurpose plant (organised unit-processwise), the manufacture of these intermediates is likely to prove viable.

Table 4—Intermediates that are Regularly Manufactured at Present

1. Sodium naphthionate
2. *m*-Phenylenediamine
3. *m*-Toluenediamine
4. Sulphanilic acid
5. BON-acid
6. G-salt
7. R-salt
8. Benzanthrone
9. Anthraquinone-2-sodium sulphonate (silver salt)
10. 1-Aminoanthraquinone
11. 2-Aminoanthraquinone
12. 4, 4'-Diaminostilbene-2,2'-disulphonic acid
13. Metanilic acid
14. Salicylic acid
15. Hydroquinone
16. *m*-Diethylaminophenol
17. Dinitrostilbene disulphonic acid
18. Dinitrotoluene
19. Schaeffers acid

Table 5—Items to be Manufactured

Sl. No.	Product	Qty proposed to be manufactured (tons)	Qty required* 1970-71 (tons)	Starting raw material at present	Saving in foreign exchange (Rs)	Saving in foreign exchange when HOC programme is implemented (Rs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	ITEMS TO BE MANUFACTURED BY 1966					
1.	*o*-Toluidine	ADC 250	386	*o*-Nitrotoluene	95,000	4,25,000
2.	*p*-Toluidine	ADC 100	391	*p*-Nitrotoluene	88,000	3,50,000
3.	*o*-Anisidine	ADC 250	354	*o*-Nitrochlorobenzene	4,30,000	10,00,000
4.	*p*-Anisidine	ADC 100	83	*p*-Nitrochlorobenzene	1,85,000	5,40,000
5.	*o*-Nitroaniline	ADC 15	NA	*o*-Nitrochlorobenzene	50,500	75,000
6.	*p*-Chloro-*o*-nitroaniline	ADC 35	45	2, 5-Dichloronitrobenzene	61,500	2,25,000

Contd

TABLE 5—*Contd*

(1)	(2)	(3)		(4)	(5)	(6)	(7)
7.	*p*-Chloroaniline	ADC	10	12	*p*-Nitrochlorobenzene	18,300	40,000
8.	*n*-Nitroaniline	ADC	75	140	*n*-Dinitrobenzene	216,000	5,25,000
9.	Diamino stilbene sulphonic acid	An	120				
		At	82				
		Ge	150				
			352	223	*p*-Nitrotoluene	28,00,000	32,92,000
10.	*p*-Amino azobenzene-4-sulphonic acid	An KCA	25 2				
			27	4	Aniline	1,60,000	2,60,000
11.	*p*-Amino azobenzene	ADC	20				
		At	20				
			40	34	Aniline	2,80,000	4,00,000
12.	2,5-Diethoxyaniline	ADC	10	15	Hydroquinone	1,75,000	1,75,000
13.	Diethylmeta-aminophenol	ADC	60	NA	Metanilic acid	6,00,000	10,20,000
14.	5-Chloro-*o*-toluidine	ADC	40	39	*o*-Toluidine	3,20,000	4,00,000
15.	G salt	KCA	50	156	β-Naphthol	1,64,000	3,00,000
	R salt	KCA	10	NA	β-Naphthol	—	—
						56,43,300	90,27,000
16.	Acetoacetanilide	Su	37.40	67	Ester aniline	12,105	—
		At	—				
17.	Acetoacet-*o*-aniline	Su	12	58	Ester-*o*-chloroaniline	25,210	
18.							
19.	Acetoacet-*p*-chloroanilide	Su	3	NA	Ester-*p*-chloroaniline	25,729	
20.	*p*-Toluidine-*m*-sulphonic acid	Su	12	NA	*p*-Toluidine	56,880	96,000
21.	*o*-Aminophenol	At		NA	*o*-Nitrochlorobenzene		
22.	Schaeffers acid	At		NA	β-Naphthol		
23.	Chicago acid	At	27.3	30	Naphthalene		
24.	Cleaves acid	At	7.3	57	Naphthalene		
25.	Dinitrostilbene disulphonic acid	At	13.2	38	*p*-Nitrotoluene		
26.	H-acid	At	113.5	190	Naphthalene		
27.	J acid urea	At	27.7	45	β-Naphthol		

Contd

TABLE 5—*Contd*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
28.	J acid	At 7.7	102	β-Naphthol		
29.	Phenyl J acid	At 7.7				
30.	*p*-Aminoacetanilide	At 5.5	16	Acetanilide		
31.	Rhoduline acid	At 8.6		β-Naphthol		
32.	Phenyl peri acid	At 8.2		Naphthalene		
33.	Laurents acid	By-product	2	Naphthalene		
34.	N-W acid	At 4.5		Alphanaphthylamine		
35.	Gamma acid	At 27.7	60	β-Naphthol		
36.	G salt	At 41.1	156	β-Naphthol		
37.	Tobias acid	At 46		β-Naphthol		
38.	Paranitroaniline	At 8.6	8.6	Acetanilide		
39.	Cyanuric chloride	Ge 150	105	Sodium cyanide	5,25,000	5,25,000
40.	Metanilic acid	Ge 30	242	Nitrobenzene	1,20,000	1,20,000

NOTE—Foreign exchange savings by Atul for each item is not given.

ITEMS TO BE MANUFACTURED BY 1967

1.	*o*-Phenilidine	At 24	14	*o*-Nitrophenol		
2.	Dichloronitrobenzene	At 40		*p*-Dichlorobenzene		
		ADC 160				
		200	335		4,00,000	4,00,000
3.	*p*-Nitrophenol	At 28.6	86	*p*-Nitrochlorobenzene		
4.	5-Chloro-*o*-toluidine	At 36	39			
5.	Sulphophenyl methyl pyrazolone	At	20	Aniline ester		
6.	2-Amino-4-nitrophenol-6-sulphonic acid	At	NA	*p*-Nitrochlorobenzene		
7.	*p*-Cresidine	At	34	Toluene		
8.	1, 7-Cleaves acid	At	NA	Naphthalene		
9.	*m*-Xyledine-*o*-sulphamic acid	At	NA	*m*-Xyledine		
10.	*o*-Aminophenol 4-sulphonic acid	At	18	Phenol		
11.	1, 2, 4-Diazo acid	At	NA	β-Naphthol		
12.	1, 8-Naphsulton	At	NA			

NOTE—Foreign exchange savings by Atul as well, the quantities for each item not given.

Contd

TABLE 5—*Contd.*

(1)	(2)	(3)		(4)	(5)	(6)	(7)
	ITEMS COULD BE MADE ONLY AFTER CAPITAL GOODS LICENCES ARE CLEARED						
1.	β-Naphthol	ADC	1000	1351	Naphthalene	22,50,000	22,50,000
2.	*o*-Chloro-*p*-nitrotoluene	Su	60	71	1 :2 Dichloro 4-nitrochloro-benzene	4,88,750	4,88,750
3.	*o*-Nitroaniline	Su	18	NA	*o*-Nitrochloro-benzene	60,000	90,000
4.	*p*-Nitroaniline	Su	30	70	*p*-Nitrochloro-benzene	37,625	
5.	*p*-Chloro-*o*-nitroaniline	Su	18	45		40,680	90,000
6.	Tobias acid	Su	396	NA			
7.	Naphthionic acid	KCA	150	NA	Naphthylamine		
8.	N-W acid	KCA	1	NA	Naphthylamine		
9.	Benzoyl J acid	KCA	1	22	J acid		
	ITEMS FOR WHICH SCHEMES ARE PENDING DISPOSAL WITH THE GOVERNMENT						
1.	*o*-Toluidine	ADC	100	164	*o*-Nitrotoluene	15,17,000	18,00,000
2.	Dianisidine	ADC	100	19	*o*-Nitrochloro-benzene	5,70,500	8,00,000
3.	C acid	Su	60	9		3,34,800	3,34,800
4.	Acetoacet-*o*-toluidine	Su	12	18	ONT+ester	6,228	
5.	Acetoacet-o-anisidide	Su	46	13	ONCB+ester	19,432	
6.	Acetoacet-*m*-xylidide	Su	6	NA	2 :4 Dimethoxy nitrobenzene +ester	26,435	
7.	*p*-Toluidine	Su	72	391	*p*-Nitrotoluene	66,000	2,45,000
8.	*o*-Toluidine	Su	8	386	*o*-Nitrotoluene	10,332	
9.	*o*-Chloroaniline	Su	2	12	PNCB	2,115	
10.	*m*-Xylidine	Su	4	NA	2 :4 Dimethyl nitrobenzene	71,680	
11.	*o*-Anisidine	Su	4	354	ONCB	16,978	
12.	*p*-Anisidine	Su	4	83	PNCB	15,715	

Contd

TABLE 5—*Contd*

(1)	(2)		(3)	(4)	(5)	(6)	(7)
13.	Phenyl methyl pyrazolone	Su	36	36	Aniline+ester	1,84,260	
14.	B acid	Su	24	NA	*p*-Nitrotoluene	1,35,780	
15.	3 : 3'Dichlorobenzidine	Su	60	67		5,61,420	

ADC — Amar Dye-Chem
At — Atul
An — Aniline Dyestuffs and Pharmaceuticals Ltd
Su — Sundershar Chemical Industry Pvt. Ltd
Ge — Suhrid Geigry Ltd
KCA — K.C.A. Private Ltd

* Ref. Statement No. 2 giving total requirement of the Dyestuff Itnermediates in 1970-71. Circular at the Dyes Panel meeting of Development Council for Organic Chemicals—December 14, 1964

1. Atul, Amar Dye-Chem, Sundershar, KCA, Aniline Dyestuffs, Suhrid Geigry only have sent the information
2. Foreign exchange saving for each item with quantities and value is given only by Sundershar and Amar Dye-Chem and Aniline Dyestuffs
3. Vat Colour Manufacturers and Colour-Chem have not complied with the request
4. Foreign exchange saving to the tune of about Rs 1 core is possible by 1966 if the schemes are implemented as scheduled
5. There may be shortfall in some of the items and therefore the balance will have to be imported. In order that the indigenous manufacturer is not at a disadvantage the fair selling price shall be decided by any competent authority and whenever shortfall is imported should be made available at the same price to all the consumers including the indigenous manufacturer at the fair selling price fixed
6. Import entitlement should be pooled and distributed equitably according to foreign exchange requirement of each unit
7. Extra allocation should be made for the manufacture of intermediates

Table 6—Dye Intermediates not covered by the Licensed Manufacturing Schemes

		Qty (tonnes)
I.	BENZENE DERIVATIVES	
1.	N-Ethylaniline	10
2.	Ethylhydroxyethylaniline	12
3.	Phenylhydrazine	24
4.	Phenylmethyl pyrazalone	36
5.	Phenylhydrazine sulphonic acid	21
6.	1-(*m*-Sulfophenyl)-3-methyl-5-pyrazalone	2
7.	3-Carboxy-1-sulfophenyl-5-pyrazalone	7
8.	1-(*p*-Sulfophenyl)-3-methyl-5-pyrazalone	20

Contd

TABLE 6—*Contd*

		Qty (tonnes)
9.	*p*-Aminoazobenzene sulphonic acid	20
10.	Methylaniline	5
11.	Methylhydroxyethylaniline	7
12.	2,5-Dimethoxy-4-chloroaniline	8
13.	2,5-Diethoxyaniline	15
14.	Dimethylaniline	486
15.	Michler's Ketone	22
16.	Benzene sulphochloride	46
17.	*o*-Aminophenol-4-sulphonic acid	18
18.	6-Nitro-2-aminophenol-4-sulphonic acid	6
19.	*p*-Chlorophenol	42
20.	2-Aminoanisic acid anilide	6
21.	Benzene-*m*-disulphonic acid	30
22.	Resorcinol	10
23.	*o*-Nitrophenol	61
24.	*o*-Aminophenol	27
25.	*N, N*,-Diethyl-4-methoxy metanilamide	5
26.	2-Amino-4-nitrophenol-6-sulphonic acid	10
27.	1, 2, 4-Trichlorobenzene	12
28.	2, 4, 5-Trichloroaniline	6
29.	1, 2-Dichloro-4-nitrobenzene	78
30.	2, 5-Dichloronitrobenzene	386
31.	4-Chloro-2-nitrophenol	7
32.	4-Chloro-2-nitrophenol-6-sulphonic acid	8
33.	4-Chloro-2-aminophenol-6-sulphonic acid	7
34.	1-Chloro-4-nitro-6-sulphonic acid	—
II.	TOLUENE DERIVATIVES	
1.	2,2 (*m*-Tolylimino)-diethanol	6
2.	*p*-Toluidine-3-sulphonic acid	26
3.	Dehydrothio-*p*-toluidine sulphonic acid	25
4.	*o*-Chlorotoluene	7
5.	*o*-Chlorobenzalchloride	11
6.	*o*-Chlorobenzaldehyde	16
7.	*p*-Chlorotoluene	46
8.	3-Nitro-4-chlorotoluene	54
9.	3-Nitro-4-methoxytoluene	46
10.	*p*-Cresidine	34
III.	NAPHTHALENE DERIVATIVES	
1.	Naphthosultam	3
2.	1-Cyanonaphthalene-8-sulphonic acid	22
3.	Chromotropic acid	2
4.	Benzazyl acid	10
5.	Diazo-1, 2, 4 acid	2
6.	Oxy-Tobias acid	—
7.	Naphthalene-1, 5-disulphonic acid	—
8.	C-Acid	9

The NCL will be in a position to develop know-how for these items provided industry comes forward to sponsor this work.

Incentives to Manufacturers of Intermediates

The Convener of this Group has been pleading for some years past (since 1962) for a realistic reappraisal of duty structure on dye intermediates depending on their chemical complexity in order to give an incentive for their indigenous production. His plan for such a duty revision was approved in principle by the Development Council for Organic Chemical Industries in 1963. Later a Sub-Committee of the Dyes Panel of this Committee recommended a simplified procedure for achieving the same objectives. Briefly it stipulates that if an intermediate B is prepared from an intermediate A, then duty on A & B should be levied at the rate of 10 per cent or less and 50 per cent or more respectively. This duty protection should be given no sooner production is reported to DGTD and further protection may also be sought later from the Tariff Commission so that indigenous price and import price (based on a tariff value to be fixed plus duty) should be levelled.

The present author is of the opinion that the above recommendations, if accepted by the Govt of India, will have a profound accelerating effect on the dyestuff industry in its march towards self-sufficiency. Indeed these recommendations are really basic and of wider application to all industries as well. If adopted, they will provide incentives for progressive entrepreneurs who are inclined to be self-reliant as regards their intermediate requirements.

As far as the dyestuff industry is concerned, for self-reliance, maximum effort must be devoted to indigenous production of intermediates and to the manufacture of speciality (low weight/high price) items where there is a shortfall between consumption and the production.

What are the Problems of the Dyestuff Industry?

Some of the top priority items where present production appears inadequate (or is absent) are given below. Also listed are useful areas of research and development which are likely to fetch useful dividends to the dyestuff industry.

Dyes

Indigo, Hydron Blue, Sulphur Blues, Copper phthalocyanine derivatives (perchloro, Alcians, Reactive Dyes and solvent stable and speciality pigments)

Alizarin and its derivatives; Acid anthraquinone dyes; Dispersible dyes of the anthraquinone series; Dioxazine pigments and sulphonated derivatives

Naphthoquinone pigments (pyrocoline pigments)

Intermediates

HOC items (as per programme envisaged between 1960-1964)

Intermediates imported for which domestic production is not adequate (Table 7)

Table 7—Import of Intermediates for Dyestuff Industries during April 1964 to March 1965*

Items	Quantity	Value
1. Acetoacetanilide	12,401	66,005
2. *p*-Aminoacetanilide	2,022	20,152
3. *p*-Aminoazobenzene	9,044	42,655
4. Benzidine/benzidine dihydrochloride	449,513	27,06,846
5. β-Naphthol	12,73,967	27,54,262
6. Benzaldehyde	1,06,776	4,12,134
7. Carbolic acid comml	4,93,286	6,72,442
8. Chicago acid	8,270	1,51,100
9. Chlorobenzene	2,96,904	3,48,043
10. *o*-Dichlorobenzene	1,29,941	1,71,755
11. Diethylanilide	14,835	54,364
12. Dinitrochlorobenzene	14,43,585	13,55,470
13. *m*-Dinitrobenzene	34,686	67,257
14. Gamma acid	13,017	1,19,722
15. G salt	28,525	1,22,450
16. H-acid	1,41,401	8,48,895
17. Laurent acid	99	610
18. *p*-Nitroaniline	11,176	33,418
19. N.W. acid	1,963	15,685
20. Phthalic anhydride	41,65,493	47,80,294
21. Pyridine	4,03,293	14,94,357
22. Resorcinol	49,135	3,50,850
23. Rhoduline acid	9,323	2,47,005

*Data supplied by DGTD

Table 8—Intermediates of varying Complexity including Penultimate Intermediates based on HOC Programme

Item	Tons/annum	Item	Tons/annum
1. Dimethylaniline	1200	7. *o*- and *p*-Chloroanilines	100
2. 2-Nitroanisol	330	8. 4-Chloro-2-anisidine	50
3. 4-Nitroanisol	85	9. Dichloroaniline	20
4. 4-Chloro-2-nitroanisol	70	10. *m*-Nitrochlorobenzene	100
5. Toluidines	500	11. *m*-Chloroaniline	70
6. Anisidines	300	12. 1, 4-Dichloro-2-nitrobenzene	110

Anthraquinone from Indian coal-tar anthracene

2-Aminoanthraquinone from 2-chloroanthraquinone

Intermediates of varying complexity including penultimate intermediates based on HOC programme (Table 8) and required by the large (and small scale) dyestuff industry and by pigment manufacturers.

How to tackle the above Problems?

Most of these problems could indeed be tackled by the research staff of the industries themselves given the chance by their employers. For the rest, IITs, the technology departments of universities and the CSIR laboratories are quite capable of solving these problems within a definite and short time target provided the industry sponsors this effort.

Equipment Requirements of the Dyestuff Industry

Whereas majority of the equipment required by the dyestuff industry is indigenously produced, the following equipments need to be imported:

> Glass lined reactors, high pressure autoclaves (500 psi.), Venuleth driers, spray driers, vacuum cube driers, Werner-Pfaudler kneader mixers, rubber-lined filter presses and centrifuges, stainless steel sheets of all types; high pressure seals, heavy-duty reduction gears and fluid drives etc.

MERDO may undertake preparation of prototype machines so that from the basic designs worked out by MERDO, chemical plant manufacturers will be able to fabricate these plants.

Export Potential

Increasing amounts of dyes are now being exported. It is quite feasible for India not only to export dyes but also to export know-how and turn-key type dyestuff plants especially to Middle East and some Eastern European countries. These possibilities should be explored.

RUBBERS & PLASTICS

The approach to this problem has to be long term and short term and implementation of it should be based on raw materials available immediately or are likely to be available in the foreseeable future. For this reason it would be necessary not only to take up problems of immediate interest from point of view of import substitution based on available raw materials, but to also initiate research and development schemes for materials which may be available in the near future for ultimate products for which there is immediate and future growing demand. Illustrative of this are the following examples where priorities of research and development work have to be given.

Section I: Rubbers

The limitations of the availability of natural rubber in India have compelled attention to production of styrene-butadiene general purpose synthetic rubbers. The Bareilly Synthetic Rubber plant is a manifest example of import substitution of rubbers both natural and synthetic and based on indigenous by-product chemicals or raw materials like ethyl alcohol and benzene. Even when these rubbers represent close to 80 or 90 per cent of the present demand in India, a few speciality rubbers are inevitably essential for specialised location which will have to be imported till substitutions are possible.

Neoprene rubbers. The one important rubber required is neoprene which is a special non-inflammable chemical resistant rubber. Technology and know-how for neoprene manufacture are closely controlled by a few corporations in the world and the requirements in the country do not justify an elaborate plant at fantastic cost both on capital account as well as industry, engineering etc. The raw materials for neoprene are acetylene chlorine and hydrochloric acid together with sample catalyst like cuprous chloride. The processes are known. What is required is development work pertaining to design of the plant. The immediate requirements of neoprene are of the order of 1500–2000 tons if freely available and demand would increase with its local production. Due to the very essential requirement of neoprene it is imperative that development work should be started on priority basis for this rubber in the country.

Nitrile rubbers. Consumption of nitrile rubbers is relatively low and presently does not exceed some 500–700 tons, but could increase substantially if freely available in several grades. Here again, it is produced by emulsion polymerisation technology and the limitation is nonavailability of acrylonitrile for which licence has been given and it is expected that it would be available in bulk beginning from 1968 and later. If foreign know-how is sought, it would mean substantial cost both in foreign exchange as well as engineering equipment. Butadiene which is the largest component for nitrile rubbers is available in the country and would be available in future also and therefore the development work to be initiated now on this subject would mean not only a very critical need for this rubber especially in the Petroleum industry, but also in many other applications requiring oil resistance.

Thiokol rubber (Polysulphide rubber). Although these kinds of rubbers are not very much in use, their development in the country would be very simple as the starting raw materials are chlorinated ether and alkali polysulphide. Since these rubbers have extremely high oil resistance and chemical resistance they would prove to be useful materials for Indian industrial usages and it is desirable to have their development established till such time that we are able to build up a more economical line of other speciality rubbers. The need for such rubber would be of the order of 300–400 tons at least.

Silicon rubbers. By far, the most important rubbers which would be very badly required by defence as also in many industrial operations involving high and extremely low temperatures resistance as well as substantial chemical resistance are the Silicon rubbers. This is an extremely new technology and also it is highly sophisticated and patent controlled. The defence would need these rubbers in many areas if available. The technology is rather difficult and requires special and expensive glass equipment. Nevertheless, in view of their wide range utility in many areas of industry and consumable requirements, a basic development programme should be laid out for this in order to ensure that within the next five years we may be able to develop at least a few important grades of rubbers as also resinous products such as for antifoam, for medicinal uses, for lubrication as additives and for many important textile applications such as waterproofing, flame-proofing etc. If developed it would also, to a very great extent, meet the need for high temperature resistance in rubbers which would normally be the acrylic rubbers which will have to be otherwise developed. This is an example of both fundamental research as also applied research. Its importance to the country is very great and therefore high priority for work on this should be given.

The other new rubbers with substantial market demand in the foreseeable future would be ethylene-propylene rubbers, propylene-oxide rubbers, butyl rubbers and poly-butadiene rubbers or equivalent stereo rubbers. These rubbers are of general purpose nature in terms of large tonnage usage. The technology and know-how of these would be available from many areas of the world and in these areas at least it would be somewhat more economical for India to buy the know-how as was done by Japan, Germany, UK, France, Italy and even Canada for faster take off in this line. This would illustrate the point that where general purpose large tonnage products are required and where know-how is available from several parties in foreign countries, it would be desirable to consider foreign know-how with a view to reach a take off stage much faster in India and to catch up with western industry.

In addition to the above, a number of lattices of neoprene, nitrile rubbers and styrene-butadiene rubbers in high solids are needed by the industry to-day in many areas for textile, paper, foam, leather and coir applications. It is possible with the basic technologies available now to develop our own processes once the basic knowledge of polymerisation techniques is learnt.

Section II: Plastics & Resins

This is a large growing field and the plastics industry if enabled to develop on the lines presently being considered by the Planning Commission would in the next few years become a giant industry with very large quantities of materials for industrial as well as consumable applications and also meeting the needs of import substitution for a large number of non-ferrous metals in many areas. A good beginning has been made in manufacture of thermo setting plastics like P.F. plastics & resins, U.F. plastics & resins, M.F. plastics & resins, polyesters and in the case of thermoplastic materials with polystyrene, polyethylene and polyvinyl chlorine. Substantial programmes for all these have been laid out and in many cases it is expected that within the next 2-3 years very large quantities of raw materials would be available. It would therefore be inadvisable to pursue any development work in the above lines. However, there are many other additives required for these bulk plastic raw materials on which would depend the successful outcome of these materials. Even here considerable progress has been made such as in the production of formaldehydes, pentaerythritol hexamine, urea and styrene. By next year or so phenol is expected to be available which would give a tremendous fillip to the development of phenol formaldehyde plastics and resins. Similarly, the Trombay methanol plant once on stream in the next few months would make available methanol from which formaldehyde and its products are made and which would catalyse further development of thermo-setting plastics and resins industry.

On the other hand, there are several gaps in the plastics industry which should be made good if possible by indigenous development of know-how. In this area would come the M.M.A. plastics & resins, epoxy plastics and polyurethanes. The establishment of these plastics is limited by the following inhibiting factors:

(a) Nonavailability of malamine which can be produced now from urea and for which either foreign technology should be purchased or development work should be started. Malamine formaldehyde would, if produced in large bulk and cheaply, contribute substantially to replacement of wide variety of household utensils for which stainless steel, brass, etc. are used in extensive quantities. This would also be a supplement to the tremendous shortage of wood and timber for building and construction purposes.

(b) The M.M.A. plastics have a tremendous use not only for defence in respect of aeroplanes, bombers, but also in transportation and consumer industries. M/s Excel Industries have done excellent work on this project and have developed not only know-how for the production of monomer but also of polymer as well as for casting of the same into sheets and other products. Their handicap is in the know-how of cyanides and supply of acetone which will be available from the Herdilia complex in another two years. Meanwhile it would be advisable to do some development work on hydrocyanic acid as it would be very helpful in not only meeting the basic requirements for this plastics but also to help the electroplating and gold extraction industries for which these cyanides are required in very large bulk. The acrylic plastics and the moulding powders should have very much value and it is known that the know-how for the entire plant alone is well over a million dollars, apart from the large construction cost and foreign exchange required if this is purchased from abroad. Also acrylic acid if produced would be a suitable material for production of acrylic rubber about which reference has been made in the earlier section for high temperature resistant rubbers.

(c) Polyurethane is now becoming an important section of elastomer industry. Fortunately we have a surplus of toluene and the development of isocyanates industry is an important preliminary to the development of elastomers. The polyglycol would be now available in plenty and it is therefore necessary to initiate work on the nitration of toluene as a first step, also development of process technology for phosgene gas for preparation of isocyanates. This programme could lead to very substantial volume of industrial development in this field as the foam alone is not only a defence material for cold weathers but it is used in many other applications. Isocyanate resins are also of very great importance to the coating industry etc. and therefore high priority should be given to this development work. I understand that Shri Ram Institute has done enough laboratory work on this subject. The foreign know-how for the entire programme would cost a fortune and therefore it is desirable that this programme should be initiated in India. At full rate of development I see a possibility of the business in terms of millions of lb. of finished material.

(d) As a matter of long range problem of work in the plastic field, the whole branch of co-polymer and ter-polymer technology leading to extremely interesting industrial and consumable products is waiting to be developed. This would also lead to substantial development of industrial production. Instances are:

(i) Styrene acrylonitrile plastics and resins made by thermal or emulsion polymerisation systems (as moulding powders alone the demand could be built up into several thousand tons).

(ii) Development of A.B.S. plastics based on butadiene acrylonitrile system. Here again the technology if purchased from abroad would literally cost over half a million or one million dollars only for know-how fees apart from the large size cost towards constructions of the plant involving again foreign exchange.

(iii) The co-polymers of vinyl chloride, vinyl acetate and many other newer co-polymer system. They have interesting possibilities in many fields of industries like textiles as pigment carriers, as lacquers which could save lot of tin for packing industry and could have useful compounds for various applications. This part of the work therefore can only be developed if the CSIR were to organise a laboratory from amongst the present laboratories strictly for high polymer research and development work. This is the field for which an entirely centralised laboratory is really necessary which presently CSIR does not have. Some interesting work in this line has been done with interesting results by the Shri Ram Institute which it is understood is likely to be taken over by the CSIR and it would be indeed not only desirable but essential that an Institute like that with a band of enthusiastic scientists be developed exclusively for the high polymer research work. In this way a mass of data and technical know-how and scientific cadre can be built up. This is all the more necessary because many monomers like styrene, vinyl chloride, vinyl acetate, acrylonitrile, butadiene isobutylene and other basic materials like phenol, cresol, formaldehyde, etc. are going to be available in very large quantities during the next 2-3 years. Another interesting example that would be cited for a forward development work is in respect of a basic programme for manufacture of PVA polymer for the production of PVA fibre which can be called as a synthetic cotton. The know-how for this fibre is available only in one country and also from essentially one or two Japanese firms. This know-how is expected to be very very expensive and the know-how would include not only know-how for vinyl acetate to PVA polymer but also for spinning of fibre starting with PVA. In addition, the Japanese know-how also tags on the know-how for the manufacture of vinyl acetate from acetylene. The need for producing cotton-like fibre in India synthetically is paramount considering the fact that we are today importing something like 100,000 tons of cotton at an annual cost of Rs 65 to 70 crores involving substantial foreign exchange. This fibre is very similar to cotton in all respects apart from having superior qualities of synthetic fibre. Since vinyl acetate could be available from Koyali and NOCIL programmes in big quantities, it should be possible to develop in one of the chemical laboratories the programme of polymerising vinyl acetate to PVA and in one of the fibre laboratories for building up know-how for the spinning of the same. Incidentally, PVA is spun from water solution and fibre is insolubilised partially by acetalisation. This fibre can be used on all cotton machineries for spinning, weaving and finishing in all respects which would indicate the tremendous advantage India can obtain by developing this technology or as a lever to obtain better terms from the foreign country in view of its exclusive position.

(iv) One of the growing fields of industry is the development of ion and cation exchange resins. With the availability of styrene in bulk the only handicap for developing this field is the nonavailability of divinyl benezene which is a difficult material but could be made starting with diethyl benzene. As soon as this material is available the ion exchange resin can be built up in substantial volume in India and this could build up a sizable industry in India especially in all those areas where brackish water is available both for industry as well as for home consumption. The package deionizer plants for home services are becoming a common feature in many western countries. In many areas in India even for drinking water people have to be satisfied with brackish water and this would therefore catalyse the revolution.

(v) Development of nylon both for fibre as well as for plastic industry would be helped considerably with the production of caprolactum. However, it is still another 3 to 4 years before caprolactum could be available in bulk. Here again polymerisation techniques are fairly simple for the moulding industry and for which work can be commenced from now on. As the quantity of nylon for plastic industry required is not very much presently it would be of tremendous help. With the production of fluorine compound in India the field becomes ripe for the development of teflon type of plastics which have a tremendous impact on the chemical industry as a corrosion resistant and high temperature resistant plastic liner material. Here again the fluorination is relatively easy but would require enough development work for building this technology.

The polyester technology could be given a great boost with the development of maleic hydride without which it is becoming difficult to make headway. Even when process know-how has been developed in Shri Ram Institute it appears as if no progress has been made. Here is an item where substantial pilot plant work needs to be done to prove that the full know-how and engineering data can be built up in India. Similarly, with the availability of epoxy chlorohydrins from the chlorinated solvents or the likely availability of ethylene oxide it should be possible to build up epoxy resin fields which are also very suitable materials for many chemical industries. It is important to realise that on all these it is possible to buy know-how from abroad, but the requirement is not of that magnitude, yet know-how fees will have to be very large and since the tonnage programme could be of manageable dimensions well within the limitations of the plant fabrication capacity in India. It is in such areas as above where a great deal of research and development effort should be expended.

Tables 9 to 12 give data on production and raw material requirements of plastics industry.

PAINTS, RESINS, SURFACE COATINGS, ADHESIVES

The Polymer Chemistry Division at the NCL will be able to handle projects on the following problems: (a) ion exchange resins, (b) phenolic and urea resins, (c) different types of adhesives, (d) rosin derivatives for different applications, (e) surface coating compositions based on synthetic resins, (f) can-sealing compositions, (g) rubber chemicals, including anti-oxidants, accelerators and blowing agents, and (h) polystyrene foams. Production of paints, breakdown during Third and Fourth Plans and the raw material requirement of paints industry are given in Tables 13 to 15.

MISCELLANEOUS CHEMICALS

Table 16 gives summarised information in respect of chemical raw material requirements of heavy organic chemicals, pharmaceuticals and perfumery industries in terms of licensed capacity, actual production and gap between demand and production.

INDUSTRIAL ORGANIC CHEMICALS

Considerable emphasis has been laid on the petrochemical and downstream industries during the Fourth Five-Year Plan. Three petrochemical

Table 9—Production Targets for

(tonnes)

Item	Production target for 3rd Plan	Capacity as on 1-1-1964		
		Operating	Under-implementation	Pending and likely to be approved
PLASTIC AND RESINS				
Polyethylene	24,000	7,500	10,000	20,000
Polypropylene	4,000	—	—	—
PVC resins	13,000	3,600	27,600	30,000
Polystyrene	13,000	6,000	8,000	8,000
Cellulose acetate moulding powder	5,340	*	6,500	3,500
Methacrylate	3,000	—	—	—
Polyvinyl acetate	2,450	*	3,000	8,000
Urea resins for plywood	8,000	4,000	3,300	—
Urea moulding powder	4,450	1,080	—	—
Melamine moulding powder	—	—	—	—
Phenolic moulding powder	6,700	4,500	—	—
Phenolic resins	—	—	—	—
Melamine and other resins (including epoxy and polyurethane)	—	—	—	—
Polyurethane	890	—	—	—
Nylon moulding powder	—	—	—	—
Others	1,340	—	—	—
Total plastics and resins				

*Small production from imported monomesor chemicals.

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Table 10—Revised Targets

Item	Capacity (t/a)
PLASTICS	
Polyethylene	1,15,000
P.V.C.	1,10,000
Polystyrene	50,000
Phenol formaldehyde	18,000
Urea formaldehyde	25,000
SYNTHETIC RUBBERS	
SBR, polybutadiene, butyl etc.	1,00,000

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Contd

Plastics for the Fourth Plan

Estimated requirements			
For indigenous consumption	For export	Total	Remarks
60,000	10,000	70,000	Includes all grades
5,000	1,000	6,000	Excluding fibres
(1,05,000)	(20,000)	(1,25,000)	
60,000	10,000	70,000	
(80,000)	(15,000)	(95,000)	
30,000	3,000	33,000	
(37,000)	(8,000)	(45,000)	
10,000	1,000	11,000	Including C.A.B.
4,000	—	4,000	
10,000	(included)	10,000	Proportion of export cannot be specified mainly for paints to be confirmed with paints targets
15,000	—	15,000	Mainly adhesives and includes chipboard
6,000	600	6,600	
1,500	—	1,500	
9,000	1,000	10,000	
4,500	—	4,500	Includes laminate
6,000		6,000	
5,000	—	5,000	
500	—	500	Exclude fibre
6,500	1,000	7,500	
2,33,000	27,600	2,61,600	

Figures in parentheses are revised figures of targets

TABLE 10—*Contd*

ITEM	CAPACITY
MISCELLANEOUS	(t/a)
Carbon black	60,000
Butanol	16,000
Methanol	60,000
Formaldehyde	77,000
Phthalic anhydride	25,000
Ethyl alcohol	3,15,000
Benzene	1,74,000
Phenol (excluding caprolactum)	10,000

Table 11—Basic and Primary Organic Chemicals

Item	Production target if any for 3rd Plan	Capacity as on 1-1-1964		
		Operation	Under implementation	Pending and likely to be approved
Synthetic rubber	50,000	20,000	10,000	—
Carbon black	35,000	10,000	23,600	—
Rubber chemicals	3,000	2,250	1,980	750
Caprolactum	—	—	5,000	—
Acrylonitrile	—	—	—	—
Dimethyl terephthalate	—	—	—	—
Plasticisers	—	900 +600	9,000	15,000
Phenol	14,000	—	19,600	—
Styrene monomer	24,000	16,000	10,000	7,000
Maleic anhydride	2,000	—	1,500	—
Phthalic anhydride	10,000	—	15,000	—
Formaldehyde	—	13,200	—	—
Toluene diisocyanate	—	—	—	—
Melamine	—	—	—	—
Cellulose nitrate	—	—	—	—
Methanol	21,500	—	33,000	—
Ethyl alcohol	2,00,000	1,70,000	90,000	—
Benzene	52,000	26,000	28,000 (coke ovens) 15,000 (petro)	33,000 (petro)
Naphthalene	15,000	7,800	4,800	—
Ethylene (petro)	50,000	—	15,000	60,000
Propylene (petro)	—	—	7,000	28,000
Acetylene	18,000	8,000	16,000	—
Butadiene/isoprene (petro)	—	—	—	—

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Production Targets for 1970-71

Estimated requirements 1970-71			Remarks
For indigenous consumption	For export	Total	
87,000	—	87,000	Exports of tyres and rubber articles are included
60,000	—	60,000	Includes use of 5000 tons in non-tyre uses
6,800	—	6,800	
24,000	—	24,000	Exports as processed material. Includes tyred cord possible substitute for other polyamides will reduce this
12,000	—	12,000	Mainly for fibres
12,000	—	12,000	Possible replacement by Terephtha acid
28,000	—	28,000	Out of this 23,000 tons will be phthalates
12,000	—	12,000	Excludes use for caprolactum
45,000	—	45,000	
3,500	—	3,500	
22,000	—	22,000	
71,000	—	71,000	As 37%
2,500	—	2,500	Other isocyanates are also included
1,500	—	1,500	
2,000	—	2,000	Excludes defence
80,000	—	80,000	Includes captive unit of 25,000 tons for isoprene
2,80,000	—	2,80,000	Production is in relation to the availability of molasses
1,33,000	—	1,33,000	
17,000	—	17,000	Relates to the availability from coal-tar
1,25,000	—	1,25,000	Assessed as additional to alcohol based production
70,000	—	70,000	Assessed as co-product of ethylene
Not assessed	—	—	Figures refer to calcium carbide based production only
95,000	—	95,000	Part of this would be replaced by isobutylene if butyl rubber is to be made

Table 12—Growth Rate Estimates

	1960-61	1965-66	1970-71	Annual growth rate %
Plastics	10,000	50,000	3,40,000	47
Synthetic fibres	nil	5,000	88,000	77.5
Synthetic rubbers	nil	30,000	1,00,000	27

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Table 13—Production of Paints—Actual

Year	Quantity (tons)	Year	Quantity (tons)
1956	24,604		
1957	47,276	1961	59,088
1958	48,000	1962	64,428
1959	54,240	1963	69,312
1960	50,716	1964	75,384

Table 14—Breakdown of Third and Fourth Plan Targets

(in tons)

	Third plan	Fourth plan
I. WATER PAINTS	8,000	17,000
Water paints (dry)		
Water paints (wet)		
II. GENERAL PURPOSE PAINTS	80,000	1,20,000
III. STRUCTURALS	33,000	32,000
Red lead paint		
Aluminium paint		
Air drying bituminous blacks		
Ship bottom paint		
Natural resin air drying enamels		
IV. INDUSTRIAL TRANSPORT AND ELECTRICALS	29,000	54,000
N.C. lacquers including ancillaries		
Insulating varnishes		
Bituminous stoving blacks		
Stoving enamels and varnishes		
Synthetic air drying enamels and varnishes		
Target capacity for surface coating materials	1,90,000	2,25,000
Target production (annual)	1,50,000	2,00,000

Table 15—Estimated Consumption of Raw Materials for Paint Industry

Sl. No.	Description	Actual consumption in 1959 (tons)	Suggested for final adoption in 1966 (tons)	Remarks
(1)	(2)	(3)	(4)	(5)
1.	Titanium dioxide (Anatase) (IEE)	1,100	9,250	
2.	Titanium dioxide (Rutile) (IEE)	720		
3.	Zinc oxide (to be substituted by TiO_2) (IED)	5,000	14,000	From imported Zn
4.	White lead (IED)	450	1,200	From imported Pb
5.	Antimony oxide	10	30	
6.	Carbon black (only furnace-I black is made at Durgapur)	150	300	Printing inks and rubber
7.	Ultramarine blue (IED)	90	175	
8.	Prussian blue (IIM)	130	275	$K_4Fe(CN)_6$
9.	Phthalocyanine blue (IEE)	20	50	
10.	Red lead (IIM)	1,500	15,500	From imported Pb
11.	Litharge (IIM)	100	300	
12.	Synthetic iron oxide (IED)	190	450	
13.	P.G. red oxide (imported)	890	1,800	Can be substituted by synthetic iron oxide or ochres
14.	Toludine Red (IIM)	25	55	
15.	Natural Redoxide (Ochre) (IED)	1,800	7,000	
16.	Chrome colours (IED)	470	900	From imported Pb
17.	Brunswick Green (IED)	80	175	From imported Pb & $K_4Fe(CN)_6$
18.	Lake colours (IIM)	10	30	Imported inorg. & org. salts
19.	Chrome oxide (Green) Cr_2O_3	15	30	Can be made
20.	Pigment Dyestuffs other than (IIM) (Phthalocyanine Blue and Teluidine Red)	100 330	700 1,750	
21.	Aluminium Paste (IEE)			
22.	Bronze Powder (imp.)	5	15	
23.	Cuprous oxide (imp.)	40	72	
24.	Murcuric oxide (imp.) (IIM)	5	15	Imported Hg
	EXTENDERS			
25.	Whiting (Soft $CaCO_3$)	2,740	5,500	Can be substituted by precipitated $CaCO_3$

Contd

TABLE 15—*Contd*

(1)	(2)	(3)	(4)	(5)
26.	Blanc Fixe ($BaSO_4$) precipitated	280	600	Barium chemicals
27.	Asbestine (Mg silicate)	140	450	
28.	Hyflo Supercel	20	50	
29.	Paris White	360	800	
30.	China Clay	830	3500	Can be substituted by Indian China Clay
31.	Barytes (IED)	9,130	21,000	
	DRYING OILS			
32.	Linseed oil (IED)	9,200	35,000	
33.	Castor oil (IED)	390	1,500	
34.	Tung oil	450	1,500	
35.	Tobacco seed oil (IED)	30	100	
36.	Coconut oil (IED)	50	175	
37.	Safflower oil	80	250	
	RESINS			
38.	Resin (IIM)	2,500	7,000	
39.	Ester gum (IED)	290	650	
40.	Copal gum	200	600	
41.	Dammer and Batu gum	50	100	
42.	Shellac (IED)	50	75	
43.	Alkyd resins (IIM)	2,270	11,000	
44.	Phenolics (IIM)			
	(a) Pure	150	650	
	(b) Modified	250	1,300	
45.	Maleic resins (IIM)			
	(a) Pure	50	300	
	(b) Modified	60	300	
46.	Urea formaldehyde resins (IED)	200	1,000	
47.	P.V.A. Emulsion (IIM)	150	500	
48.	Coumarone resins	80	350	
49.	Melamine resins (IIM)	60	300	
50.	Resins other than (43-49)	240	1,250	
51.	Chlorinated rubber	20	120	

Contd

TABLE 15—*Contd*

(1)	(2)	(3)	(4)	(5)
	SOLVENTS	*Unit in gallons*		
52.	White Spirit (IED)	23,62,200	50,00,000	
53.	Vegetable Turpentine (IED)	56,420	1,00,000	
54.	Solvent Naptha (Heavy) (IED)	85,550	1,50,000	
55.	Solvent Naptha (Light) (IED)	88,800	1,60,000	
56.	Denatured spirit (IED)	1,37,425	2,50,000	
57.	Benzene (IED)	4,980	1,000	
58.	Toulene (IED)	1,13,940	2,50,000	
59.	Xylol (IED)	85,800	2,00,000	
60.	Pine oil (IED)	8,480	7,000	
61.	Dipentine (IED)	24,120	45,000	
62.	Butyl alcohol (IEE)	64,470	1,20,000	
63.	Diacetone alcohol (NOCIL)	23,950	40,000	Can be made
64.	Methyl ethyl ketone (NOCIL?)	53,520	90,000	
65.	Methyl isobutyl ketone (")	21,930	40,000	
66.	Butyl acetate	68,990	140,000	Proposed to be made
67.	Ethyl acetate (IED)	6,290	12,000	
68.	Cellosolve	15,890	30,000	
69.	Methyl cyclohexanone	1,060	2,000	
70.	Ethyl glycol monobutyl ether	5,200	10,000	
71.	Ethylene glycol monoethyl ether	9,740	18,000	
72.	Glycerine (IED)	81,730	1,45,000	
73.	Naphthenate driers (IIM)	180	900	
74.	Nitrocellulose (IED)	220	700	
75.	Phthalic anhydride	840	4,000	Herdelia Durgapur
76.	Pentaerythritol	150	1,100	
77.	Gilsonite	360	1,300	
78.	Lacithin	4	15	
79.	Maleic anhydride	40	125	

IED — Indigenous—enough for domestic demand
IEE — Indigenous—not enough
IIM — Indigenous based on imported raw materials

Table 16—Chemical Raw Material Requirements, Licensed Capacity, and Perfumery

(Figures are in tonnes per annum

Sl. No.	Chemicals	Pharma-ceutical industry	HAL	IDPL	Perfumery industry	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Acetanilide	2000	—	(1282)	—	2000
2.	Acetic acid	690	—	(548)	—	690
3.	Acetic anhydride	1598	—	(193)	—	1598
4.	Acetoacetic ester	135	—	—	—	135
5.	Acetone	1210	(240)	(413)	—	1210
6.	Acetone semicarbazone	8	—	—	—	8
7.	Acetyl acetone	312	—	—	—	312
8.	*p*-Acetyl-aminophenol	20	—	—	—	20
9.	Acetyl chloride	4.4	—	—	—	4.4
10.	Acrolein	9.5	—	—	—	9.5
11.	Acrylonitrile	88	—	(35)	—	88
12.	Aluminium chloride (anhydrous)	83.5	—	—	—	—
13.	4-Amino-2, 6-dimethyl-pyridine	50	—	—	—	50
14.	Aminohydantoin sulphate	1.5	—	—	—	1.5
15.	*o*-Aminophenol	27	—	—	—	27
16.	*m*-Aminophenol	7000	—	—	—	700
17.	*p*-Aminophenol	24	—	—	—	24
18.	2-Aminopyridine	4.4	—	—	—	4.4
19.	2-Aminopyrimidine	350	—	—	—	250
20.	2-Aminothiozole	55	—	—	—	55
21.	Ammonium thiocyanate	381	—	—	—	381
22.	Aniline	80	—	99	—	179
23.	Anthranilic acid	15	—	—	—	15
24.	Anisaldehyde	6.4	—	—	—	6.4
25.	Arquad (lbc)	516	—	—	—	516
26.	Benzaldehyde	262	—	(0.5)	30	292
27.	Benzyl chloride	33	—	(14)	—	33
28.	Benzyl cyanide	25.5	—	—	—	25.5
29.	Butyl acetate	1500	540	(1025)	—	2004
30.	*n*-Butanol	800	222	(619)	—	1022
31.	*tert.* Butanol	100	—	—	—	100
31a.	Isobutanol	—	—	—	—	—
32.	*n*-Butylamine	12·5	—	—	—	22.5
33.	Butyl malonic diethyl ester	11.5	—	—	—	11.5
34.	Capryl alcohol	1.6	—	—	—	1.6
35.	Ethyl cellosolve	606	—	—	—	606
36.	*m*-Chloroaniline	103	—	—	—	103
37.	Chloroacetyl chloride	1.8	—	—	—	1.8

Actual Production, Imports and Gaps in Production of Pharmaceutical Chemical Industries

unless otherwise indicated)

IVth Plan requirements (8)	Licensed capacity (9)	Actual prodn (10)	Imports (11)	Gap (12)	Lab. that can provide know-how (13)
—	2000	—	12.4	2000	
35000	14000	—	4.1	—	
—	11545	—	664	—	
—	3000	—	—	—	
27000	11400	624	2112	586	
—	—	—	—	8	NCL
—	118	—	—	312	
—	40	—	—	20	CDRI
—	50	—	—	4.4	
—	—	—	—	9.5	
12000	—	—	—	88	
—	8492	—	1745.6	1829	NCL
—	—	—	—	50	
—	—	—	—	1.5	CDRI
—	—	—	—	27	
—	—	—	—	700	RRL, Hyd
—	—	—	—	24	
—	—	—	—	4.4	NCL
—	—	—	—	250	
—	64	—	—	55	
—	—	—	—	381	
9000	3500	—	—	179	NCL
—	—	—	—	15	NCL
—	—	—	—	6.4	NCL
—	—	—	—	516	
—	112	—	106.7	292	NCL
—	210	—	11.3	33	RRL, Hyd
—	—	—	—	25.5	
—	3740	—	853.5	2004	
15000	4850	—	975	1022	
—	—	—	—	100	
—	—	—	218	218	
—	—	—	—	22.5	NCL
—	—	—	—	11.5	NCL
—	—	—	—	1.6	
—	—	—	—	606	
—	70	—	2.1	103	
—	—	—	—	1.8	NCL

Contd

TABLE 16—*Contd*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
38.	*p*-Chlorobenzene sulphonamide	45	—	—	—	45
39.	*p*-Chloronitrobenzene	430	—	—	—	430
40.	2-Chloropropyldimethylamine HCl	3.1	—	—	—	3.1
41.	2-Chlorophenothiazine	3.6	—	—	—	3.6
42.	Chlorosulphonic acid	9400	—	(5263)	—	9400
43.	Citric acid	51	—	(18)	—	51
44.		—	—	—	—	—
45.	Cobalt nitrate	0.8	—	—	—	0.8
46.	*o*-Cresol	—	—	—	—	—
47.	Cyanoacetic ester	28.5	—	—	—	28.5
48.	7-Dehydrochlortetrol	2.4	—	—	—	2.4
49.	Dibutyl ether	2	—	—	—	2
50.	4, 7-Dichloroquinoline	50	—	—	—	50
51.	Dicyandiamide	896	—	(490)	—	896
52.	Diethylamine	134.4	—	—	—	134.4
53.	2-Diethylamine ethanol	102	—	—	—	102
54.	4-Diethylamino-1-methyl butylamine	30	—	—	—	30
55.	Diethyl carbonate	7.2	—	(12.5)	—	7.2
56.	Diethyl ethoxy methylene malonic ester	110	—	—	—	110
57.	Diethylmalonate	114.5	—	—	—	114.5
58.	Diethylmethylamine	2	—	—	—	2
59.	Diethyl oxalate	70	—	—	—	70
60.	Dimethylamine	1	—	—	—	1
61.	Dimethylaminochloroethane HCl	6.4	—	—	—	6.4
62.	1-Dimethylamino-2-chloropropane HCl	3.6	—	—	—	3.6
63	Dimethyl sulphate	327	—	(111)	—	327
64.	Dinitrobenzoyl chloride	2.2	—	—	—	2.2
65.	Diphenyl oxide	166	—	—	10	176
66.	Ergosterol	4	—	—	—	4
67.	Ethyl bromide	32.4	—	(9)	—	32.4
68.	Ethylene dichloride	357	—	(160)	—	359
69.	Ethyl orthoformate	90	—	—	—	90
70.	Ethylene oxide	172	—	70	—	242
71.	5-S-Ethyl-1-methyl-butyl malonite	—	—	—	—	—
72.	Ethyl palmitate	8	—	—	—	8
73.	Ethyl isopentylmalonate	—	—	—	—	—
74.	Formaldehyde 30%	1391	—	—	—	1391
75.	Formamide	40	—	—	—	40
76.	Formic acid	347.5	—	(179)	—	347.5
77.	Gelatin	4	—	—	—	4
78.	Glucose	1030	—	—	—	1030

(8)	(9)	(10)	(11)	(12)	(13)
—	—	—	—	45	CDRI
—	355	—	—	430	
—	—	—	—	3.1	NCL
—	—	—	—	3.6	CDRI
—	15488	—	—	9400	
—	2068	—	1200	51	NCL
—	—	—	—	0.8	
—	—	—	—	—	
—	—	—	—	28.5	
—	—	—	—	—	
—	—	—	—	2.4	
—	—	—	—	2	NCL
—	—	—	—	50	
—	—	—	—	896	
—	—	—	—	134.4	NCL
—	—	—	—	102	NCL
—	—	—	—	30	CDRI
—	—	—	—	7.2	
—	—	—	—	110	
—	—	—	—	114.5	
—	—	—	—	2	NCL
—	—	—	—	70	NCL
—	—	—	—	1	
—	—	—	—	6.4	NCL
—	—	—	—	3.6	NCL
—	—	—	—	327	NCL
—	—	—	—	2.2	RRL Hyd, NCL
—	—	—	65	176	
—	—	—	—	4	
—	36	—	—	32.4	
19375	10000 gal.	5000	49	—	
—	—	—	—	90	
12000	300	—	—	242	
—	—	—	—	—	NCL
—	—	—	—	8	RRL Hyd, NCL
—	—	—	—	—	NCL
75000	13200	—	369	1391	Percentage is not given
—	—	—	—	40	NCL
—	1700	—	433	347.5	
—	4800	—	—	—	
—	2200	—	326.3	1030	

Contd

Table 16—*Contd*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
79.	*z*-Glutamic acid HCl	31.5	—	(6)	—	31.5
80.	Guanidine nitrate	32	—	(6)	—	32
81.	Hexamethylene tetramine	67	—	—	—	67
82.	Hydrazine hydrate	225	—	—	—	225
83.	Hydrazine sulphate	315	—	—	—	315
84.	Hydroxyethyl hydrate	3	—	—	—	3
85.	*p*-Hydroxynaphthoic acid	2.5	—	—	—	2.5
86.	Indulin B	18	—	—	—	18
87.	Iodine	100	—	(3)	—	100
88.	Isopropyl alcohol	386	16.8	—	—	402.8
89.	Ketoacetol	8.8	—	—	—	8.8
90.	Lithium metal	0.8	—	—	—	0.8
91.	Magnesium metal	2.5	—	—	—	2.5
92.	Methoxy pyridoxin	22.5	—	—	—	22.5
93.	Methanol	2035	1287	(651)	—	3322
94.	Methylamine 40%	38	—	—	—	38
95.	Methylbenzene sulphonate	129	—	—	—	129
96.	Methyldichloroacetate	65	—	—	—	65
97.	Methylene chloride	40	—	—	—	40
98.	Methyl ethyl pyridine	2	—	—	—	2
99.	Methylformate	40	—	—	—	40
100.	Methylisobutylketone	500	—	—	—	500
101.	Methylmonochloroacetate	13	—	—	—	13
102.	2-Methylnaphthalene	6.5	—	—	—	6.5
103.	2-Methyl-2-propyl-3-diol	2.5	—	—	—	2.9
104.	Monochlorobenzene	297	—	—	—	297
105.	Monoethanolamine	100	—	152	—	252
106.	Nickel catalyst	2.1	—	13.5	—	15.6
107.	*p*-Nitroacetophenone	69	—	—	—	69
108.	Nitrobenzene	15.5	—	—	—	15.5
109.	*p*-Nitrobenzoyl chloride	39.5	—	—	—	39.5
110.	Nitrofurfural diacetate	23.2	—	—	—	23.2
111.	*o*-Nitrophenol	61	—	—	—	61
112.	*p*-Nitrotoluene	254	—	—	—	254
113.	Oxalic acid	97.8	—	484.6	—	581.6
114.	Palladised charcoal	1.3	—	—	—	1.3
115.	Palladium catalyst	15	—	—	—	15
116.	Palladium chloride	0.4	—	—	—	0.4
117.	Palmipoyl chloride	9.1	—	—	—	9.1
118.	Pancreas	10	—	—	—	10
119.	Phenol	186.6	—	—	—	186.6
120.	Phenothiazine	3.4	—	—	—	3.4
121.	Paraformaldehyde	10	—	—	—	10
122.	Phenoxyacetic acid	—	6.4	—	—	6.4
123.	Phenylacetamide	53	—	—	—	53
124.	Phenylacetic acid	—	69	—	—	69

(8)	(9)	(10)	(11)	(12)	(13)
—	—	—	—	31.5	
—	—	—	—	32	RRL, Hyd
—	1200	—	—	67	
—	—	—	—	225	
—	—	—	—	315	
—	—	—	—	3	CDRI
—	—	—	—	2.5	NCL
—	—	—	—	18	
—	—	—	100	100	To be imported
—	—	—	407	402.8	
—	—	—	—	8.8	NCL
—	—	—	—	0.8	
—	—	—	—	2.5	
—	—	—	—	22.5	NCL
80000	—	—	9884	3322	
—	—	—	—	38	
—	—	—	—	129	NCL
—	60	—	—	65	NCL
—	1680	—	—	40	
—	—	—	—	2	
—	—	—	—	40	
—	—	—	229	500	NCL
—	—	—	—	13	NCL
—	—	—	—	6.5	NCL
—	—	—	—	2.9	
—	3500	—	—	297	
—	300	—	—	252	To be imported
—	—	—	—	15.6	NCL
—	—	—	—	69	NCL
—	7000	—	134	15.5	
—	—	—	—	39.5	NCL
—	—	—	—	23.2	CDRI
—	—	—	—	61	
—	—	—	—	254	
—	1595	—	306	581.6	
—	—	—	—	1.3	
—	—	—	—	15	
—	—	—	—	0.4	
—	—	—	—	9.1	RRL, Hyd
—	—	—	—	10	
12000	3000	—	2465	186.6	HSL will produce about 1340 t.p.a. in addition
—	—	—	7	3.4	CDRI
—	—	—	—	10	
—	20	—	—	6.4	NCL
—	232	—	—	53	RRL, Hyd
—	203	—	—	69	RRL, Hyd

Contd

TABLE 16—*Contd*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
125.	Phenylethylamine	22.5	—	—	—	22.5
126	Phosgene	8	—	56	—	64
127.	Phosphorus oxychloride	68	—	—	—	68
128.	Phosphorus pentasulphide	78	—	—	—	78
129	Phosphorus pentoxide	20	—	—	—	20
130.	Phosphorus trichloride	5	—	—	—	5
131.	α-Picoline	335	—	(181.5)	—	335
132.	γ-Picoline	565	—	—	—	565
133.	Piperazine hexahydrate	6.5	—	—	—	6.5
134.		—	—	—	—	—
135.	Potassium borohydride	1	—	—	—	1
136.	Potassium carbonate	700	29	—	—	729
137.	Potassium cyanate	90	—	—	—	90
138.	Potassium hydroxide	1.5	252	—	—	253.5
139.	Potassium phenylacetate	500	—	—	—	500
140.	Procaile HCl	58	—	—	—	58
141.	Propargyl bromide	10.8	—	—	—	10.8
142.	*n*-Propylamine	23	—	—	—	23
143.	Pyridine	150	—	—	—	150
144.	Salicylic acid	2600	—	—	—	2600
145.	Sodamide	1.5	—	—	—	1.5
146.	Sodium benzoate	60	—	—	—	60
147.	Sodium citrate	180	—	—	—	180
148.	Sodium cyanide	15	—	16	—	31
149.	Sodium diethyldithiocarbamate	4	—	—	—	4
150.	Sodium ferrocyanide	9	—	—	—	9
151.	Sodium metal	134	—	235	—	369
152.	Sodium methoxide	13.5	—	—	—	13.5
153.	Sodium nitrate	18	12	—	—	30
154.	Sodium nitrite	272	—	(59)	—	272
155.	Stearyl alcohol	5.5	—	—	—	5.5
156.	Tartaric acid	260	—	—	—	—
157.	*o*-Toluidine	9	—	—	—	9
158.	Trichloroethylene	67	—	—	—	67
159.	*p*-Toluene sulphonamide	45	—	—	—	45
160.	Trimethylquinyl	—	—	—	—	—
161.	Thionyl chloride	230	—	(111)	—	230
162.	Triethylamine	150	—	—	—	150
163.	Urea	85.6	—	—	—	85.6
164.	Urethane	4.6	—	—	—	4.6
165.	Xylene	809	—	—	—	809
166.	*m*-Xylidine	1.9	—	—	—	1.9
167.	Zinc dust	28	—	—	—	28
168.	Activated carbon	—	2.4	—	—	2.4
169.	Activated carbon (Noritt)	—	0.4	—	—	0.4

(8)	(9)	(10)	(11)	(12)	(13)
—	—	—	—	22.5	RRL, Hyd
—	—	—	—	64	To be imported
—	—	—	—	68	
—	300	—	—	78	
—	60	—	643.7	20	
—	600	—	—	5	
—	50	—	—	335	NCL
—	127	—	—	565	CDRI
—	—	—	—	6.5	
—	—	—	—	—	
—	—	—	—	1	
—	1500	—	1244	729	
—	—	—	—	90	
—	—	—	3708	253.5	
—	—	—	—	500	RRL, Hyd
—	100	—	8	58	CDRI
—	—	—	—	10.8	NCL
—	—	—	—	23	
—	72.5	—	403	150	
—	600	—	707	2600	
—	—	—	—	1.5	
—	—	—	52	60	
—	—	—	—	180	
—	360	—	1042.1	31	To be imported
—	—	—	—	4	NCL
—	360	—	—	9	
—	300	—	19	369	To be imported
—	—	—	—	13.5	NCL
—	—	—	939.7	30	
—	—	—	2164.9	272	
—	—	—	6.1	5.5	RRL, Hyd
—	260	—	459	—	
—	500	—	—	9	
—	—	—	2001	67	To be imported
—	—	—	—	45	
—	—	—	—	—	
—	—	—	39	230	NCL
—	—	—	—	150	NCL
—	—	17412	8157.8	—	
—	—	—	—	4.6	
—	—	—	—	809	
—	—	—	—	1.9	
—	—	—	—	28	
—	—	588	387	—	
—	—	—	—	0.4	

Contd

Table 16—*Contd*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
170.	Acti. carbon (Pittsburgh)	—	30.7	—	—	30.7
171.	Brewers yeast	—	—	90	—	90
172.	Calcium chloride	—	240	280	—	520
173.	Calcium carbonate	—	1.8	1037	—	1038.8
174.	Dibenzyl ethylene diamine diacetate	—	3.6	—	—	3.6
175.	Hyflosupercel	—	48	—	—	48
176.	Milorganite	—	2	—	—	2
177.	Nycon feon 219	—	1260 m.	—	—	1260 m.
178.	Nylonmultifilament	—	480 m.	—	—	480 m.
179.	Octadecanol	—	15	—	—	15
180.						
181.	Sodium bisulphite	—	0.5	—	—	0.5
182.	Tween 20	—	0.2	—	—	0.2
183.	Tween 80	—	1.4	—	—	1.4
184.	Versene	—	0.4	—	—	0.4
185.	Phthalic anhydride	—	—	—	—	28000
186.	Aniline oil	—	—	—	—	—
187.	Dioctyl phthalate	—	—	—	—	—
188.	Dinitrochlorebenzene	—	—	—	—	—
189.	Beta-Naphthol	—	—	—	—	—
190.	Diacetone alcohol	—	—	—	—	—
191.	Accelerators	—	—	—	—	—
192.	Antioxidants	—	—	—	—	—
193.	Tetrachloroethane	—	—	—	—	—
194.	Chlorobenzene	—	—	—	—	—
195.	Carbon tetrachloride	—	—	—	—	—
196.	Chloroform	—	—	58	—	58
197.	Cresylic acid (pure)	—	—	—	—	—
198.	Cresylic acid (comml)	—	—	—	—	—
199.	Pentaerythritol	—	—	—	—	—
200.	Ethylene glycol	—	—	—	—	—
201.	Methyl ethyl ketone	—	—	—	—	—
202.	Dodecyl benzene	—	—	—	—	—
203.	Dibutyl phthalate	—	—	—	—	—
204.	Vinyl acetate	—	—	—	—	—
205.	Dichlorobenzene	—	—	—	—	—
206.	Benzylacetate	—	—	—	40	40
207.	Aniline salt	—	—	—	—	—
208.	Resorcinol	—	—	—	—	—
209.	Toluene	—	—	444	—	444
210.	Lactic acid	—	—	—	—	—
211.	Amyl alcohol	—	—	—	—	—
212.	Monochloroacetic acid	—	—	15	—	15
213.	Benzoic acid	—	—	26	—	26

(8)	(9)	(10)	(11)	(12)	(13)
—	—	—	—	30.7	
—	—	—	—	90	
—	—	—	2.1	520	
18000	—	4600	6008.1	—	
—	—	—	—	3.6	
—	—	—	—	48	
—	—	—	—	2	
—	—	—	—	1260 m.	
—	—	—	—	480 m.	
—	—	—	—	15	
—	—	—	2	0.5	
—	—	—	—	0.2	
—	—	—	—	1.4	
—	—	—	—	0.4	
22000	12300	—	4165	28000	This quantity is required for making 40,000 tons of plasticizers
—	—	—	1441	1441	
—	—	175	2878	2878	
—	—	—	1444	1444	
—	—	—	1274	1274	
—	—	3800	1423	1423	
—	—	—	450	450	
—	—	—	611	611	
—	—	—	565	565	
—	—	—	297	297	
—	—	—	259	259	
—	—	1080.8	331	331	
—	—	—	405	405	
—	—	—	578	578	
—	—	2150	734	734	
—	—	—	773	773	
—	—	—	201	201	
—	—	—	124	124	
—	3300	—	134	134	
—	—	—	121	121	
—	—	—	130	130	
—	191.12	3.5	110	110	
—	—	—	705	705	
—	—	—	49	49	NCL
—	—	2000	55.7	—	
—	—	—	45	45	
—	—	—	71	71	
—	2400	—	40	55	To be imported
—	53	—	34	60	To be imported
—	—	—	84	84	

Contd

TABLE 16—*Contd*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
214.	Amyl acetate	—	—	—	—	—
215.	Tricresyl phosphate	—	—	—	—	—
216.	Diethanolamine	—	—	—	—	—
217.		—	—	—	—	—
218.	Benzyl alcohol	—	—	—	—	—
219.	Maleic anhydride	—	—	—	—	—
220.	Benzyl benzoate	—	—	—	5	5
221.	Pentachlorophenol	—	—	—	—	—
222.		—	—	—	—	—
223.		—	—	—	—	—
224.	Adipic acid	—	—	38	—	38
225.	Benzene sulphonic acid	—	—	65	—	65
	methyl ester	—	—	—	—	—
226.		—	—	—	—	—
227.	*o*-Anisidine	—	—	0.6	—	0.6
228.	*o*-Xylene	—	—	10.5	—	10.5
229.	*p*-Nitrobenzoic acid	—	—	12.4	—	12.4
230.	*p*-Nitrochlorobenzene	—	—	131	—	131
231.	Acetophenone	—	—	—	3.5	3.5
232.	Aldehyde C_7	—	—	—	25	25
233.	Aldehyde C_9	—	—	—	0.2	0.2
234.	Aldehyde C_{11} (undecylenic)	—	—	—	0.5	0.5
235.	Aldehyde C_{12} (lauric)	—	—	—	0.1	0.1
236.	Aldehyde C_{12} (MNA)	—	—	—	0.8	0.8
237.	Aldehyde C_{18} (nonlactone)	—	—	—	0.01	0.01
238.	Aldehyde C_{14} (undecalactone)	—	—	—	0.2	0.2
239.	Aldehyde C_{16} (ethyl methyl phenyl glycidate)	—	—	—	1	1
240.	Anethole	—	—	—	2	2
241.	Anisic alcohol	—	—	—	0.1	0.1
242.	Anisic aldehyde	—	—	—	1	1
243.	Benzophenone	—	—	—	1	1
244.	Cinnamyl acetate	—	—	—	4	4
245.	Cinnamyl alcohol	—	—	—	0.5	0.5
246.	Cinnamic aldehyde	—	—	—	5	5
247.	Citral dimethyl acetal	—	—	—	0.3	0.3
248.	Coumarin	—	—	—	8	8
249.	Cyclamen aldehyde	—	—	—	5	5
250.	Decanlo	—	—	—	1	1
251.	Dimethyl benzyl carbinyl acetate	—	—	—	0.3	0.3
252.	Dimethyl octanol	—	—	—	0.5	0.5
253.		—	—	—	—	—
254.	Eugenol	—	—	—	1	0.1
255.	Heliotropine	—	—	—	1	1
256.	Indole	—	—	—	0.2	0.2

(8)	(9)	(10)	(11)	(12)	(13)
—	—	—	27	27	
—	—	—	14	14	
—	166	—	21	21	
3500	1500	—	19.5	19.5	
—	2.5	—	96.8	96.8	
—	—	—	6	6	
—	—	—	—	—	
—	—	—	—	—	
—	—	—	—	38	
—	—	—	—	—	
—	—	—	—	65	To be imported
—	—	—	—	—	
—	—	—	—	0.6	To be imported
—	—	—	—	10.5	
—	—	—	—	12.4	To be imported
—	—	—	10.3	131	To be imported
—	—	—	0.7	3.5	To be imported
—	—	—	—	25	
—	0.10	—	—	0.2	
—	0.25	0.1	—	0.4	
—	0.12	0.05	—	0.05	
—	0.1	—	—	0.1	
—	0.1	—	—	0.1	
—	0.1	0.1	—	0.1	
—	0.5	0.5	—	0.5	
—	—	—	—	2	
—	—	—	—	0.1	
—	—	—	6.3	1	
—	10	—	—	1	
—	—	—	—	4	
—	—	—	—	0.5	
—	10	—	6.3	5	
—	—	0.1	—	0.2	
—	—	—	22.9	8	
—	2	—	—	5	
—	—	0.1	—	0.9	
—	—	—	—	0.3	
—	—	—	—	.7	
—	—	0.3	—	—	
—	—	—	4·5	1	
—	—	—	—	0.2	
—	—	0.05	—	0.45	

Contd

TABLE 16—*Contd*

(1)	(2)	(3)	(4)	(5)	(6)	(7)
257.	Isoeugenol	—	—	—	0.5	0.5
258.	Limalyl acetate	—	—	—	8	8
259.	Menthol	—	—	—	30	30
260.	Methyl anthranilate	—	—	—	0.5	0.5
261.	Methyl naphthyl ketone	—	—	—	0.1	0.1
262.	Methyl phenyl carbinyl acetate	—	—	—	3	3
263.	Octanol	—	—	—	0.5	0.5
264.	*p*-Cresyl acetate	—	—	—	0.1	0.1
265.	*o*-Cresyl phenyl acetate	—	—	—	0.5	0.5
266.	Phenyl ethyl acetate	—	—	—	1	1
267.	Phenyl ethyl alcohol	—	—	—	40	40
268.	Terpineol	—	—	—	40	40
269.	Terpinyl acetate	—	—	—	0.5	0.5
270.	Trichloromethyl phenyl carbinyl acetate	—	—	—	2	2
271.	Vanillin	—	—	—	5	5

NOTES ON COLUMNS

Col. 3 — Data abstracted from the PDC Panel of the Development Council, DGTD

Col. 4 — Data obtained from Hindustan Antibiotics

Col. 5 — Survey carried out by the Indian Drugs and Pharmaceuticals Ltd, for their Synthetic Drugs and Antibiotics Projects

Col. 6 — Data provided by Hindustan Lever, Bombay

Col. 8 — *Chem. Ind. News*, April 1965, p. 731

units—Union Carbide, NOCIL and Koyali—are expected to go on stream during the five year span of fourth plan. One could say that it is planned to introduce a new petrochemical unit almost every year during 1967, 1968 and 1969. Whether our existing industry and the envisaged future manufacturing units would be able to absorb the products of all these 3 petrochemical units within the brief span of 5 years or not is questionable. "Should the growth and investment in the petrochemical operations be spread over a longer span?" is a question that needs to be looked into thoroughly.

In suggesting the above the importance of the petrochemicals industry to the growth of the organic chemicals industry in India is not questioned. Merely the rate at which these petrochemical units should be put on stream needs to be reconsidered.

From the point of foreign exchange saving, it is essential that the manufacturing know-how for a particular product once purchased should be utilised as far as possible, to meet the increased demands for that product, rather than to establish new units involving further foreign exchange expenditure for the purchase of know-how from various other sources. Thus, the establishment of several PVC manufacturing units in collaboration with different foreign concerns means a repetition of the foreign exchange expenditure for purchase of know-how. The same principle should be kept in mind in issuing licences for various other products.

(8)	(9)	(10)	(11)	(12)	(13)
—	1.5	—	—	8	
—	324.5	—	43.8	30	
—	5	—	—	0.5	
—	—	—	—	0.1	
—	—	—	—	3	
—	—	0.05	—	0.45	
—	—	—	—	0.1	
—	2	—	—	0.5	
—	—	2	—	—	
—	—	—	47.2	47.2	
—	150	—	211.8	212	
—	—	—	—	0.5	
—	—	3	—	—	
—	36	—	16.2	21.2	

Col. 9 — List of Industrial Undertakings Licensed, ICMA Publication

Col. 10 — Monthly Statistics of the production of selected industries of India, Chemical Age of India, Vol. 16, p. 370, May 1965.

Col. 11 — Monthly Statistics of the Foreign Trade of India, Vol. II, Imports, March, 1965.

Cols. 4 and 5 — Figures mentioned in brackets are included in Col. 3.

The priority assigned to various manufacturing operations should be consistent not only with the essentiality of a product, but also with the market demand. Licensing capacities for intermediates which are likely to be used in manufacturing units still to be established may involve difficulties, if the product to be manufactured needs foreign technical know-how, market development, large capital investment etc.; butadiene can be cited as an example. Anticipating establishment of a polybutadiene rubber plant, a licence for the manufacture of butadiene has been issued. Investment on this butadiene unit has already been committed, but still there is no indication of a polybutadiene rubber manufacturing unit being established, particularly because such units have to be of adequate capacity to be economical and it is doubtful, if at this stage, a sufficiently large unit can be run at a reasonably high production level.

The manufacturing capacities of established units have increased considerably during the last few years and a further expansion in these capacities is anticipated during the fourth plan. Most of these units are based on foreign technical know-how, because of which they are depending to a large extent on imported catalysts, auxiliary chemicals, additives, colorants, etc. The import bills of these materials, because of the increased capacities of the basic manufacturing operations, have increased substantially and are a constant drain on our foreign exchange. Most of these materials are not required in bulk and, as such, are ideally suited for small scale manufacturing units. It should be possible to consolidate the needs of the

Table 17—Target Capacities

(in tonnes)

Sl. No.	Item	Capacity 1965-66	Target 1970-71	Capacity licensed on 1-11-65		
				In operation	Under implementation	C. G. not cleared
1.	Methanol	30,000	80,000	—	33,000	—
2.	Ethanol KL.	3,27,000	4,57,800	2,83,635	66,238	—
3.	Benzene	52,000	1,33,000	33,000	59,000	—
4.	Toluene	—	22,000	—	—	—
5.	Naphthalene	15,000	17,000	7,650	4,450	—
6.	Ethylene	—	1,25,000	15,000 (alcohol based)	78,000 (petrol based)	—
7.	Propylene	—	70,000	—	35,000	—
8.	Isopropyl alcohol derived solvents	—	—	—	1,500	—
9.	Butyl alcohol	—	150	15,400	12,710	—
10.	2-Ethyl hexanol	—	14,000	—	9,595	—
11.	Phthalic anhydride	15,000	22,000	—	12,300	10,000
12.	Maleic anhydride	—	2,500	—	—	1,500
13.	Phenol	16,000	12,000	—	16,600 21,600	—
14.	Aniline	—	9,000	—	—	6,000
15.	Detergent alkylate	—	15,000	—	—	—
16.	Dicyclopentadiene	—	1,200	—	7,000	—
17.	Toluene di-isocyanate	—	2,500	—	—	—
18.	Carbon black	—	60,000	13,750	18,500	—
19.	Rubber chemicals	3,000	6,800	2,250	1,903	—
20.	β-Naphthal	—	3,000	—	—	3,000
21.	Styrene monomer	—	45,000	16,000	10,000	—
22.	Chlorinated hydrocarbons	—	25,000	880	19,580	—
23.	Acetic acid	31,000	35,000	11,525	2,167	10,150
24.	Acetone	—	—	1,000	17,000	—
25.	Diacetone alcohol	—	—	—	4,800	—
26.	M.I.B.K.	—	—	—	3,700	—
27.	Formaldehyde	—	71,000	13,200	—	1,50,000
28.	Propyleneglycol	—	2,500	—	—	—
29.	Melamine (s)	—	1,500	—	—	—
30.	Guanidine salts	—	2,000	—	—	—
31.	Hydrogen cyanide	—	3,000	—	—	—
32.	Citric acid	—	2,000	1,500	—	—
33.	Tartaric acid	—	1,000	—	—	—
34.	Methyl ethyl ketone	—	2,000	—	—	—

and Production

Total of cols. 5,6 & 7	Actual production 1963	1964	1965 (July-Sept.)	Remarks
33,000	—	—	—	This does not include cordite factory
3,49,873	1,14,544	1,60,702	1,42,037	
92,000	18,720	17,570	15,050	One other unit has been given letter of intent
—	—	—	—	
12,100	4,415	4,465	3,046	Letter of intent have given for about 24,000 of formaldehyde
93,000	Production for styrene & polyethylene			
35,000	—	—	—	
1,500	—	—	—	Letter of intent been given for a capacity of 2000 tons/annum
14,250	1,297	730	379	
9,595	—	—	—	
2,300	—	—	—	
1,500	—	—	—	
16,600	—	—	—	
21,600	—	—	—	
6,000	—	—	—	
—	—	—	—	
700	—	—	—	
—	—	—	—	
32,200	5,264	9,403	—	
4,153	260	1,311	1,433	
3,000	—	—	—	For captive use in C.A. Plant
26,000	3,706	7,710	7,000	
20,520	147	128	—	
23,840	1,507	7,370	6,026	
18,000	902	641	513	
4,800	—	—	—	
3,700	—	—	—	
28,200	5,845	11,006	13,166	
—	—	—	—	
—	—	—	—	
—	—	—	—	
—	—	—	—	
—	1,500	—	—	
—	—	—	—	
—	—	—	—	

various industries for various products and to encourage indigenous small scale manufacturing units to produce such items from know-how to be developed in our National Laboratory. These research problems should not be too complicated and in all probability would not involve prolonged research. It should therefore be possible to develop indigenous know-how for their manufacture within a reasonably short time. It is in this respect that our National Laboratories can be of immediate assistance to the country in saving foreign exchange.

The manufacturing schemes and the progress of their implementation in respect of heavy organic chemicals will be found in the development council panel report for organic chemical industry. Table 17 gives information on production and targets of a few organic chemicals.

APPENDIX

Extracts from Papers Presented

DYESTUFFS AND INTERMEDIATES

1. Research and development in dyestuff intermediates (*B. V. Shah, Atual Products*, 2.10)

(1) To make the indigenous manufacturing facilities complete in respect of Fast Bases, the author recommends immediate establishment of production facilities to cover the gap between the manufacture of nitrotoluenes and toluidines (Amar Dye-Chem) and between nitrochlorobenzenes and anisidines.

(2) Alpha-Naphthylamine : Facilities for organising production should be provided.

(3) Toluidines and anisidines should be included in HOC programme (Amar Dye-Chem has reduction capacity).

(4) The author recommends intensive research work to be undertaken for (a) developing process know-how and plant design to bridge the gap between production and demand of dyes and intermediates; (b) finding Indian sources for scarce materials such as sulphur, potassium chloride, phosphorus, etc.; (c) to improve or replace the classical methods of manufacture of intermediates by adopting latest techniques such as fixed and fluidized bed catalysis, high pressure and high temperature technology, continuous reactions, chemical transformation by microorganisms, electrochemical reactions, ion exchange,etc.; (d) problems of corrosion and material of construction.

(5) The question of foreign collaboration should be decided on the merits of each case keeping in view (a) advantages as well as disavantages (b) limitation of qualified and competent personnel and facilities in the country; (c) the time target or the urgency of the problem; (d) importance of the product in terms of the four recent criteria laid down by the Govt of India; (e) indigenous availability of raw materials, plant, apparatus and equipment and fabrication and instrumentation facilities.

(6) Publication of a technical journal on instrumentation technology.

2. Possibilities for establishing electroorganic industry in India (*H. V. K. Udupa, CECRI*, 2.12)

The paper deals with the economic advantages of electroorganic techniques in the production of organic chemicals and dyestuff intermediates such as salicyl aldehyde, benzaldehyde, *p*-aminophenol, 2, 4-diaminophenol, *o*-aminophenol, tolualdehydes, toluidine, dianisidine, benzidine, *p*-nitrobenzoic acid, benzyl alcohol, etc. by processes of reduction or oxidation using rotating cathodes and the use of anodic synthesis of organic compounds. The author suggests the establishment of electroorganic industry in India with active collaboration of the CECRI.

ORGANIC CHEMICALS

Fine chemicals project at the NCL and its role in the development of research and industry (*P. K. Bhattacharyya, V. P. Fernandez & N. L. Dutta*, 2.11)

(1) In its brief period of existence, the FCP has not only been able to supply chromatographic adsorbents, perfumery chemicals, analytically pure organic chemicals, and laboratory reagents required in relatively small quantities by scientists engaged on teaching and research, but also a few chemicals required by the defence authorities. Nonavailability of imported raw materials has been the main handicap and the authors feel that apart from reasonable allocation of foreign exchange for importing essential raw materials required, the assistance from firms in the form of selling to NCL small quantities of raw materials imported on their licence subject to CCI&E's permission, will help the FCP in its production programme.

Comments from Dr R. T. Thampy, Shri Ram Institute—2.8

(2) Development work for some of the industrial organic chemicals such as TDI, adipic acid, maleic anhydride, dimeric fatty acids, tetrahydrophthalic anhydride, etc., on which work on laboratory scale has been done, could be planned with the active participation of the industry concerned.

RUBBER, RESINS, ADHESIVES, PLASTICS, PAINTS VARNISHES, SURFACE COATINGS

1. Gelatin and its role in photographic emulsions (*S. K. Jain*, 2.7)

The paper deals with some of the characteristics and important uses of gelatin in photographic industry. The author suggests extensive investigation of the impurities contained in gelatin which act as sensitizers or desensitizers or as retarders or accelerators of crystal growth in order to elucidate completely its mysterious behaviour. Since the raw materials required for the production of gelatin are now being exported and the final product (gelatin) is imported at a cost of about Rs 30 lakhs (200 tons of photographic gelatin required by Hindustan Photo Films), the author recommends that indigenous production should be established.

Comments from R. T. Thampy, Shri Ram Institute—2.8

(2) The author suggests that (a) thorough analysis for the possible replacement of metals (stainless steel, zinc, tin, etc.) by plastics should be carried out; (b) plastics like ABS, halogenated polyethers, special type polyesters, which are suitable substitutes for metals and on which work has been carried out, should be examined for further developmental work and large-scale exploitation, and (c) foreign collaboration for new industrial units in respect of a product already in production in the country with or without foreign collaboration should not be granted.

(3) Process know-how for the production of di-*tert*-butyl-*p*-cresol (GONOL, TOPANOL), an antioxidant required in the manufacture of high impact polystyrene should be developed. The quantity required is about 10 to 12 tons.

4. Plastics as substitutes for metals (*M. Krishnan & R. T. Thampy*, 2.21)

This paper gives exhaustive details of plastics which can replace metals, in automobile industry, railways, space crafts, defence, chemical, and engineering industries and household articles, aircrafts (both civil and military), a brief summary of which is given below :

Plastics	*Uses*	*Metals which can be replaced*
Polythene	Household articles, pipes of 2″ bore for cold water (pressures $\ngtr$ 6 atm.)	Tin plate, galvanized enamelled steel
P.V.C.	Metal pipes for water supply; container for corrosive chemicals, roofing, pipes (temp. $\ngtr 45°$)	Stainless steel, copper, lead, aluminium, asbestos and other ferrous materials

Polystyrene	Refrigerator lining containers, household articles, cistern, bath room equipment	Steel, stainless steel
Glass reinforced plastics	Materials of construction, corrosion resistance, ducts, vents, stack, etc.	Stainless steel and other metals
Reinforced plastics	Body armour, helmets, vehicular armour, gun bearings, submarine hull, shot gun barrel launching tube, tank wheel	Aluminium, nylon, armour; steel velvet

The authors suggest that an earnest attempt should be made to popularise the use of plastics in India in the above industries to save foregin exchange.

5. Selection of a process for the manufacture of vinyl chloride in India (*R.K. Bhatnagar*, 2.22)

In view of the high cost of production of vinyl chloride compared to international price, the author suggests that the petrochemical complexes in India should not restrict themselves to utilisation of naphtha as raw material, but also consider using crude oil directly, specially in establishments that shall manufacture vinyl chloride, in places distantly situated from petroleum refineries. For such establishments manufacture of acetylene and ethylene by direct cracking of crude oil and their subsequent conversion to vinyl chloride by the recently developed NOC or Chiyoda Processes will be profitable. Besides affecting considerable saving in investment, sufficient volumes of a gas mixture, ideally suited for the manufacture of synthetic fertilizer, specially urea, will be available as by-product.

(6) *Comments from Rubber Board, Kottayam*—2.6

(a) Scientific research on the agricultural and technological aspects to improve the yield per acre of natural rubber be undertaken.

(b) Manufacture of substitutes for imported components such as copper scrap for copper fungicides, Micron 420 sprayers and dusters may be examined.

7. Rubber-base compounds as substitute for tin-lead solder in the manufacture of containers (*R. Dutta*, 2.9)

The author calls for an intensified programme of work for finding out rubber-base materials as substitutes for metallic coatings for containers to prevent corrosion.

Comments from Prof. R.H. Sahasrabudhey

(8) The author recommends a programme of work to be undertaken and develop know-how for producing chemicals used as vulcanization accelerators (carbon disulphide derivatives such as 1,3-diphenyl thiocarbamide, tetramethyl thiuram disulphide, tetraethyl- diuram disulphide, tetramethyl thiuram monosulphide, mercaptobenzothiazole, mercaptobenzothiazolyl disulphide, and zinc and sodium phenyl dithiocarbamates, etc.), which are now being imported. He further suggests that other nitrogen, sulphur and non-sulphur compounds of organic and inorganic origin should be evaluted as substitutes for the more well-known compounds.

9. Lac and its products as import substitutes and industrial raw material (2.26)

This is an interesting paper analysing mainly the numerous uses of lac compositions and derivatives as a drying lacquer, jointing composition, flexible coating resistant up to —40°, wax plasticiser and resin for aircraft dope fabric, petrol resistant enamels, paints seaming and bolt-sealing compound, etch or wash primer adhesive, resin binder, etc. The author suggests that steps should be taken to establish an industry to fully utilise the shellac products and save valuable foreign exchange.

MISCELLANEOUS

Raw materials for synthetic musks and perfumery compounds (*S.A. Hakim*, 2.5)

(1) The author states that the manufacture of musks in India will save foreign exchange to the extent of Rs 20 lakhs. The raw materials required, which are in short

supply, are trichlorethylene (25 tons p.a.), *tert.* butyl alcohol (16 tons p.a.), xylene 5% (35 tons p.a.) ,*tert.* butyl xylol (34 tons p.a.) and *m*-cresyl methyl ether (25 tons p.a.). Other perfumery raw materials required are: vanillin, coumarin, terpineol, terpinyl acetate, phenyl ethyl alcohol, phenyl acetic aldehyde, heliotropin, diphenyl methane benzyl acetate**, rhodissol*, rose phenone*, phenyl acetic acid*, methyl anthranilate*, isoeugenol, α-amylcinnamic aldehyde*. The paper deals only with the raw material requirements of the firm which the author represents and does not give the entire requirements of the industry as a whole. He suggests manufacture of the items not already made in the country.

(2) Process development of 3-methyl-4-nitrophenol, an intermediate for the production of Sumithion (50-300 tons p.a.), an agricultural pesticide, should be undertaken.

Export promotion

(a) NCL can undertake work on sophisticated perfumery chemicals based on cheaply available natural products (e.g. non-edible oils, Indian turpentine, etc.).

(b) Details regarding industrial enzymes if made available, further examination can be undertaken at the NCL.

(c) Production of catalysts—V_2O_5 for H_2SO_4 in NCL.

Comments from Dr A. Lahiri (2.1)

(3) The CFRI has developed process know-how for cation and anion exchange resins from coal and tar; phthalic anhydride, for which a pilot plant unit has already been commissioned; and active carbon from coal and lignite.

4. Rubber, Adhesives and Plastics—Indigenous know-how and possible industrial research programme (*K. J. Balakrishna*, 2.2)

(1) Facilities for pilot plant production of synthetic rubbers based on styrene-butadiene, neoprene, nitrile, thiokol and silicone and special elastomers based on acrylics and diisocyanate linked condensation which are required in small quantities should be organised.

(2) Investigations to produce polyester rubbers for surface coatings purposes should be started.

(3) Regarding adhesives, the author recommends development of nondestructive testing facilities, which can be used both for primary evaluation and for assessing the state of the adhesive after ageing, under specified ambient conditions.

(4) A detailed programme of research on expoxy based adhesives and epoxy-silicone phenolics which have shown considerable promise in forming aerodynamically smooth structures at 5000°F. in air and capable of withstanding increasing stresses should be initiated.

(5) Possibilities of pilot plant production of polyamines for the preparation of polyamide-epoxy-adhesives should be explored.

(6) Production facilities for fluorocarbon polymers and silicones which will be of use in machinery and equipment industry and for military purposes should be organised.

Comments from (a) Res Chemol (P) Ltd, Calcutta and (b) Dr N. K. Bhattacharyya

(a) The firm is interested in the production of Beta-naphthol and coumarone resins for which it proposes to seek foreign collaboration. (Beta-naphthol is proposed to be produced by Amar Dye-Chem; process know-how available with CFRI for coumarone-indene resins).

(b) The author advocates the production of organic fine chemicals, required in small quantities for teaching and research (cf. 2.11 under organic chemicals,)

6. Coumarone-indene resin from crude benzole and coal-tar heavy naphtha (*S. K. Bose & N. G. Basak*, 2.13)

After surveying the earlier work on the preparation of coumarone-indene resin, the authors state that with a mixture of H_2SO_4 and phosphoric acid as catalyst, polymerization of coal-tar naphtha (160-185°C.) gives coumarone-indene resin, the quality of which could be modified by controlling the temperature of polymerization and the composition of the catalyst mixture.

**Manufactured by Morani Chemicals, Bombay.

*Manufactured in India.

7. Conversion of higher homologues of phenols to phenols and cresols (*N. G. Basak,* 2.14)

As the title indicates, this is purely a research paper giving experimental details of the procedure involved in the conversion of higher homologues of phenols to light phenols and cresols, and the preparation of a suitable catalyst. The process consists of distilling the tar acids obtained from low temperature tars in two fractions under pressure and varying temperatures and then subjecting the fraction to catalytic hydrogenolysis in two stages.

8. Anion exchange resin from tar acids, cresols and the likes (*P. N. Mukherjee & A. Lahiri,* 2.15)

The paper gives an outline of a patented process (IP 90112) for the preparation of anion exchange resin from tar acids which consists in condensing tar acids and formaldehyde followed by reaction with aliphatic amines in presence of a further quantity of formaldehyde. The economics of cost of production have been worked and the process is available for commercial exploitation.

9. Phthalic anhydride from tar oils (*A. N. Basu,* 2.16)

The paper is in the form of a semi-technical note giving details of the different coal-tar fractions used in the preparation of phthalic anhydride and the yields of the final product. Mention is also made of a suitable vanadium catalyst developed at the CFRI in this connection. The process has been patented.

10. Studies on preparation and uses of carbon (*P. K. Banerjee,* 2.17)

The paper deals with the preparation of CARBION, a cation exchanger prepared by sulphonating coal, which has uses as water softener, catalyst in hydrolysis reactions such as conversion of starch to glucose.

11. Thermosetting resin from coal-tar fractions (*C. S. B. Nair, A. N. Basu, & A. Lahiri,* 2.18)

This paper deals with the preparation of a phenolic resin containing sodium hydroxide (0.75 mole-mole). The process has been patented (IP 56581) and released to West Bengal Govt.

12. Studies on the oxidation of cumene to alpha-cumyl hydroperoxide (*N. G. Basak & A. Lahiri,* 2.19)

This is purely a research paper giving experimental details of the various steps involved in the preparation of cumene from benzene by isopropylation and oxidation of cumene to alpha-cumyl hydroperoxide, which is an important intermediate for the preparation of phenol from benzene through cumene—alpha-cumyl hydroperoxide route.

13. Oxidation of anthracene to anthraquinone (*C. S. B. Nair, A. N. Basu & A. Lahiri,* 2.20)

This paper gives details of experimental results in respect of the development of a catalytic vapour phase process for the oxidation of anthracene over a fluidized catalyst.

14. Aluminium zinc oxide composite primers (*RRL, Hyderabad,* 2.23)

This paper describes in detail the relative advantages of aluminium zinc oxide primers, which give excellent protection against rusting, and on which extensive work has been done at the RRL, Hyderabad. If the tests which are being undertaken on a large scale prove successful, aluminium zinc oxide primer will be a valuable substitute for red lead primer.

15. Hydrogenated castor oil (*RRL, Hyderabad,* 2.24)

This paper deals with a process which has been developed at RRL, Hyderabad, for the production of hydrogenated castor oil which finds wide application in organic surface coatings, plasticizers and for the preparation of antisagging and antisetting agents for the pigments in paints.

16. Surface coatings from cashewnut shell liquid (*RRL, Hyderabad,* 2.25)

This interesting paper deals with the various applications of CNSL in the preparation of bobbin enamels, acid resisting paints, anticorrosive paints, air-drying oleoresinous varnishes, internal coating compositions from the copolymers of cardanol, epoxy resins, and hydrogenated cardanol.

17. Microbes and industry (*S. R. Vyas*, 2.31)

The author outlines the significant role played by microorganisms in the development of essential products such as vitamins, antibiotics, riboflavin, amylases, proteinases, yeast, citric acid, alcohol, steroids, etc. and suggests that steps should be taken for the establishment of microbiological industries for the effective utilization of agricultural raw materials and the waste products of agro-based industries.

MINUTES OF THE MEETING OF WORKING GROUP 2 ON INDUSTRIAL CHEMICALS HELD AT 2.30 P.M. ON MONDAY, DECEMBER 20, 1965, AT NEW DELHI

Dr Tilak, the convener, briefly explained the scope, function, and purpose of the meeting in the light of the guidelines suggested by the Ministers of Education, Industry and Defence Production at the opening session of the Get-Together held earlier in the morning and suggested that the Working Group 2 might consider the various issues involved and make concrete recommendations to be placed at the concluding session of the Get-Together. In the absence of Shri D. M. Trivedi, who could not attend, Dr Tilak requested Shri Shivanand J. Shah to take the chair.

Shri Shah stated that the primary objectives of the Get-Together were to:

(a) list problems to be tackled and their order of priority

(b) ensure that a suitable machinery is established to discuss the related issues involved jointly by the industry and the CSIR

(c) ensure that follow-up action was taken on problems to be taken up for investigation

(d) arrive at a set of decisions concerning specific proble ms on which work could be undertaken in one of the CSIR laboratories or under the auspices of other research organisations, such as university departments of technology etc. on the basis of priorities to be determined by those present at the Get-Together.

The Chairman also suggested to the members present at the Get-Together that their recommendations on the following points in respect of problem to be taken up for investigation would be very helpful.

(a) whether the problem should be taken up on the initiative of the laboratory concerned

(b) whether it should be sponsored by industry or by any other interested party

(c) whether work should be initiated by the industry and one of the laboratories under thr CSIR on a 50-50 basis; or

(d) in any other manner which the gathering might decide

The Chairman mentioned that the Working Group 2 would meet jointly with the Working Group 4 for Drugs and Pharmaceuticals. He then invited the following speakers to address the gathering.

Dr B. D. Tilak (Convener), NCL, Poona

He reiterated the salient points of the key paper, which was prepared partly based on his own views and partly from the wealth of material made available to him by individual experts and by the various participants in the form of papers presented at the Get-Tegether. He briefly touched upon a few of the important topics such as problem identification, sponsored projects, cooperative research between the CSIR laboratories and the industry, statutory financial provision for expenditure on research, duty structure on basic raw materials used for producing intermediate chemical raw materials, the question of follow-up action and other related subjects. He mentioned that the key-paper would form the basis of discussion and concrete proposals emanating from the deliberations of this Working Group would be placed before the concluding session.

Dr Duldhoya, NOCIL, Bombay

When the petrochemical complex now under implementation went on full stream, the problem of utilization of the surplus capacity of chemicals produced would have to be examined much in advance. Ethylene, propylene and butadiene would become available in huge quantities and steps should be initiated urgently for investigating the production of glycols and other ether solvents, amines such as methylamines, ethanolamines ethylenediamine, antioxidants and plasticizers, auxiliary chemicals such as titanium tetrachloride and ethyl chloride.

Shri Kalyan Sen, Allied Resins Ltd, Calcutta

He drew specific attention to the versatile use of plastics such as thermoplastics, polyvinyl chloride, vinyl chloride etc. which could substitute about 80 per cent of our import needs in this field.

Prof. N. R. Kamath, IIT, Bombay

He emphasised the need for a thorough re-examination of the existing specifications in paints formulations and advocated that vigorous steps should be taken for eliminating the use of inorganic pigments derived from imported metals such as zinc, white lead, etc. and for upgrading the quality of the synthetic precipitated calcium carbonate. Work on a crash-programme basis should be initiated for the production of phthalic anhydride, maleic anhydride, pentaerythritol and co-polymers. He mentioned that paint industry did not require know-how for formulation; but if the question of raw material requirements cold be solved, the industry would become self-sufficient.

Shri L. Kumar, Adviser (Petrochemicals), Ministry of Petroleum and Chemicals, New Delhi

Surveying the progress made in the establishment of the three petrochemical complexes (Gujrath, NOCIL and Koyali), he mentioned that a variety of petro-based organic chemicals such as ethylene, propylene, butadiene, butanol, acetaldehyde, 2-ethylhexanol, polyethylene, isopropyl alcohol, acetone, diacetone alcohol, methylethyl ketone, etc. would become available in a fairly large quantities and suggested that research for the development of know-how for use of the above products should be initiated. Thus manufacturing processes for alkylamines, acids and esters derived from acrylonitrile (available in early 1969) (acrylic acid; acrylic esters), antioxidants and glycols should be investigated. Also development of engineering designs for economic size plants for these products should be undertaken. Polyethylene would remain in the field for a long time to come as one of the major plastics along with PVC, polystyrene, etc. Developing indigenous know-how for these plastics as part of a long.term fundamental programme of work should be undertaken in CSIR and other laboratories. Shri Kumar also referred to the gap in the production of insecticides for plant protection purposes and stressed the need for organising research and development know-how for a variety of insecticides which were required for agricultural and other purposes. He agreed to provide a list of such pesticides if any interested party contacted him.

Referring to foreign collaboration, Shri Kumar mentioned that where collaboration agreements which were inevitable in certain areas where development of local know-how was impossible on account of limitations of men and material or for other reasons we should follow the Japanese example, viz. buying the process outright, and effecting improvements in data and designs subsequently, which may turn out to be substantially different from the know-how purchased and may turn out much better too.

Shri A. Srinivasan, Development Officer, DGTD, New Delhi

He mentioned that the paint industry which had an annual turnover of Rs 25 crores, needed about Rs 2 crores worth of critical raw materials which have to be imported. Steps were already underway for substituting some of the imported materials such as zinc oxide and white lead, by titanium dioxide. He suggested that urgent work should be undertaken for (a) the beneficiation of ilmenite, which contained about 52 per cent of titania, with a view to improve the titanium content to 90-92 per cent and also to reduce the use of H_2SO_4; (b) the production of phthalic anhydride; and (c) developing indigenous know-how for the production of auxiliary chemicals required by plastics industry.

Dr P. K. Bhattacharyya, NCL, Poona

He briefly outlined the activities of the Fine Chemicals Project in NCL and stated that some of the chemicals required in small as well as large quantities (such as malonic acid, phenoxyacetic acid, etc.) could be made available to industry on the basis of know-how developed by the Fine Chemicals and other laboratories in the NCL.

Shri P. V. Mehta, Modi Industries, Modinagar

He stressed the unique role played by the distilleries in providing alcohol, an important industrial solvent, and cautioned that in the development of petrochemical complexes, the interests of the alcohol industry should not be overlooked.

Dr G. S. Sidhu, Director, RRL, Hyderabad

He exhorted the industry to provide financial assistance for the establishment of facilities for integrated pilot plants for unit operations, and processes for various scales of operation. The cost of such a venture would be around Rs 20 lakhs.

Dr S. M. Shah, Polychem Ltd, Bombay

The plastics industry requires a variety of additives, antioxidants, and chemicals such as ethyl chloride, aluminium chloride of specific purity. Improvement of the quality of these auxiliary chemicals could be one the problems which the national laboratories might tackle. The problems which deserve examination relate to the patent situation of the products for which indigenous know-how was recommended to be developed. Dr Shah suggested that CSIR laboratories would be particularly suited to undertake projects where association of various disciplines was essential. The industry will not be able to handle such projects which are best taken up by CSIR laboratories.

Dr D. Banerji, IRMRA, Calcutta

He stressed the need for the proper assessment of the requirements of the rubber industry in respect of raw materials and also for finding out consumer acceptability of the products produced by the industry. He recommended the setting up of a standing committee of specialists from the industry and the other research organisations to examine the problems faced by the industry in the matter of production, raw material requirements imports, defence requirements, export promotion and other allied factors so as to arrive at speedy solutions to these problems. The group could also examine and propose areas of work, where foreign know-how would be absolutely essential and those areas where indigenous skill was adequate for developing know-how, in addition to recommending product-oriented research.

Dr J. V. Asolkar

He emphasised the need for initiating vigorous schools of research on fluorine chemistry, which had been neglected in the country so far. He quoted statistics of imports of hydrofluoric acid (anhydrous) for the production of synthetic cryolite, aluminium derivatives and a large variety of other organic compounds and certain specific dyes. He suggested that (a) fluorite, which was available in the country in large quantities, must be processed in this country, for which the necessary know-how should be developed; (b) steps should be initiated for the production of hydrofluoric acid (anhydrous) and trifluoroacetic acid; (c) poduction of fluorocarbons from the petrochemicals should be investigated; and (d) a working group should be formed for examining in detail the various factors involved in the systematic development and utilization of the results obtained by the investigations on fluorine chemistry and technology.

Referring to the perfumery industry Dr Asolkar stated that alternative uses should be found out for prim rose oil, orange oil, geraniol, etc. which were available in large quantities in the Nagpur area.

Dr C. V. Seshadri, IIT, Kanpur

He informed the participants of the computer facilities available at the IIT, Kanpur, and mentioned that such facilities might be taken advantage of by the research laboratories and the industry for purposes of statistical quality control analysis.

At this stage the Chairman informed the gathering that within the limitations of time at the disposal of the Working Group. an opportunity would be given to the members of the audience to present their views after the suggestions of the ad hoc sub-committees constituted to go into the relevant problems faced by the industries with which Working Group 2 was concerned, were presented tomorrow (December 21, 1965) in the form of recommendations. The Chairman then read out the formation of the following sub-committees: (i) Industrial Organic Chemicals (Dr Kulkarni, NOCIL, Chairman), (ii) Dyes and Intermediates (Shri B. V. Shah. Chairman), (iii) Rubber, Resins, Adhesives, and Plastics (Dr Banerji, Chairman), (iv) Paints, Varnishes and Surface Coatings (Prof. N. R. Kamath, Chairman).

Tuesday, December 21, 1965

Shri B. V. Shah, Atul Products Ltd

He briefly reiterated the points mentioned in his paper on foreign technology and other problems faced by the dyestuff industry. Provision of a percentage of the sales turnover for research, he felt would be meaningful only if we could organise local facilities for the fabrication of sophisticated instruments required for research. Regarding importing foreign know-how, he was of the view that the time element and the financial requirements would be the main considerations. If the know-how was required urgently, without involving much foreign exchange, and if such know-how could not be developed locally within the time specified, permission to import know-how should be given. He also cautioned against buying obsolete foreign know-how.

Shri Santok Singh, M.P.

He offered to convey to the Parliament any points which the organisers and participants of the Get-Together wished to be conveyed.

Shri G. N. Parikh, All-India Plastics Manufacturers Association

He stated that he was totally opposed to the proposal regarding 5 per cent provision for research by industry.

Dr O. P. Sharma, Inventions Promotion Board

He outlined the activities of the IPB and drew attention to the numerous forms of incentives offered by the Board for encouraging indigenous research efforts and inventions.

After Dr O. P. Sharma, the Chairman summed up the points raised during the discussions in respect of revision of duty structure on raw materials, statutory provision for research within industry, fuller utilization of indigenous know-how, work done by the advisory panels constituted by the Executive Councils of the national laboratories, and other specific problems which could be referred to one of the CSIR laboratories for solution. He then requested the chairmen of the four sub-committees to appraise the audience of the conclusions they have arrived at.

The conclusions of the sub-committee were discussed in detail by the gathering and the final recommendations of the Working Group are appended.

The convener proposed a vote of thanks to the Chairman and the participants for their valuable contributions in making the deliberations of the Working Group 2 fruitful and constructive.

3. Inorganic and Heavy Chemicals, Fertilisers Cement and Marine Chemicals

In spite of considerable progress, the Heavy Chemicals Industry in the country is still far from self-sufficiency. A large number of items falling under the general group on 'Inorganic and Heavy Chemicals, Fertilisers, Cement and Marine Chemicals' are being still imported at least in major amounts. Our total imports of these chemicals amount to about Rs 50 crores, which is more than half of the total (approx. Rs 90 crores) imports of all the chemicals in the country. The subject assumes even a much higher importance from the point of view of 'Fertilisers' which are vital inputs for self-sufficiency in foodgrain production. In Table 1 are presented some data regarding indigenous production, imports in 1964-65 and estimated requirement in 1970-71 of various major chemicals included for consideration in our working group. A perusal of the data in Table 1 shows that our current annual imports (in lakhs of rupees) are those of fertilisers 2928; zinc 1047; tin 1028; sulphur 542; caustic soda 330; carbon black 129; sodium hydrosulphite 63; titanium dioxide 62; soda ash 60; gypsum 35; borax 22; acetylene black 20; phosphorus 19; bleaching powder 16; sodium sulphate 15; sodium nitrite 11 and Activated carbon 10. The available data on our estimated requirements at the end of the fourth plan show that these imports are likely to increase much further unless steps are taken to bring about manifold increase in our indigenous production.

Table 1—Indigenous Production, Import for 1964 and Estimated Requirement for 1970-71

Sl. No.	Chemical	Indigenous production (tons)	Imports		Estimated requirement (tons)
			Qty (tons)	Value (lakhs Rs)	
(1)	(2)	(3)	(4)	(5)	(6)
1.	Fertilisers				
	(i) Nitrogenous (N)	1,20,537	6,51,955	2050.00	2 million
	(ii) Phosphatic (P_2O_5)	1,23,935	47,678	277.00	1.2 million
	(iii) Potassic (K_2O)	nil	86,764	211.00	0.5 million
	(iv) Mixed	—	60	0.30	
	(v) Crude	—	4,32,754	390.00	
			12,19,211	**2928.30**	
2.	Zinc	—	66,399	1047.90	
3.	Tin				
	(i) Plates	—	52,416	514.56	
	(ii) Blocks	—	3,344	513.63	
			55,760	**1028.19**	

Contd

TABLE 1—*Contd*

(1)	(2)	(3)	(4)	(5)	(6)
4.	Sulphur				
	(i) Natural	nil	2,77,781	539.00	
	(ii) Refined	nil	464	2.50	
			2,78,245	**542.00**	
5.	Caustic soda	1,91,809	67,706	330.00	340,000
6.	Carbon black	—	10,684	129.00	
7.	Sodium hydrosulphite	—	3,292	62.83	
8.	Titanium dioxide	4,305	3,050	62.00	
9.	Soda ash	2,97,099	33,473	60.00	700,000
10.	Gypsum	30,000	1,00,459	34.60	
11.	(i) Borax acid	450	2,460	22.00	
	(ii) Borax	3,500	—	—	
12.	Acetylene black	—	717	20.16	
13.	Phosphorus				
	(i) Red	nil	350	14.98	
	(ii) Yellow	nil	170	4.12	
			520	**19.00**	
14.	Bleaching powder	7,995	2,312	16.00	
15.	Sodium sulphate	—	5,864	15.11	
16.	Sodium nitrite	nil	2,164	11.36	
17.	Activated carbon	906	387	10.60	
18.	Magnesium compounds				
	(i) Magnesium oxide	—	42	1.60	
	(ii) Magnesium carbonate	—	559	5.64	
	(iii) Magnesium hydroxide	—	12	0.71	
	(iv) Other salts	—	35	0.72	
			648	**8.67**	
19.	Cement	97,83,900	1,866	7.29	
20.	Potassium ferrocyanide	—	297	5.76	
21.	Bromine	138	121	4.04	
22.	Aluminium chloride	—	175	3.84	
23.	Sodium nitrate	nil	940	3.48	
24.	Potassium cyanide	nil	78	2.73	
25.	Sulphuric acid	6,93,210	10	1.21	
26.	Potassium ferricyanide	—	25.5	0.75	
27.	Nitric acid	12,767	17	0.38	
28.	Manganese dioxide	—	12	0.25	
29.	Hydrochloric acid	23,528	1.6	0.11	

Twenty-three papers dealing with various aspects of this working group were received and the information supplied has been utilised in the preparation of this paper.

Alkali Industry

The first major industry belonging to this group is the Alkali industry producing caustic soda and soda ash. We have been importing very large quantities of both these chemicals; in 1964-65, 67,706 tons of caustic soda valued at Rs 330 lakhs and 33,473 tons of soda ash valued at Rs 60 lakhs were imported. The indigenous production has also been rising at quite a fast rate, but has not been able to keep pace with the requirements so far.

There are at present 27 factories in the country with total production capacity of about 1100 tons of caustic soda per day. Seven more factories are under various stages of erection with an installed capacity of 345 tons per day. Similarly, four soda ash plants produce about 900 tons of soda ash per day and three more units each of 200 tons per day are under various stages of erection. The present trend of development has been in favour of putting bigger size units which are more economical. Recently, emphasis is being laid in establishing caustic soda chlorine integrated units. This is likely to reduce the price of caustic soda appreciably and encourage further growth of caustic industry by more and more utilisation of chlorine. Soda ash units are being based on modified Solvay process which gives an important co-product, namely ammonium chloride of fertiliser quality.

The price of caustic soda and soda ash is considerably higher in India as compared to the international prices. In a paper (3.8) presented in this group, interesting information has been collected on the price structure of the alkali industry in various countries. Salt, which is a basic raw material for these industries is produced in very large quantities in India. The production and supply position is quite satisfactory. However, in spite of this the price of the alkali continues to be high (Table 2).

The reasons for high prices of caustic soda and other chemicals essential for industry should be looked into and serious efforts should be made to scale them down so that other industries based on these essential raw materials can grow in more favourable cirumstances.

Chlorine

Large quantities of co-product chlorine are available from the electrolytic alkali industry. Chlorine used to be regarded rather a liability and lack of its suitable disposal and utilisation became a bottleneck in the growth of the alkali industry. In more advanced countries, the position has been reversed.

Although a beginning has been made in our newer industrial units, effective steps must be taken for proper and full utilisation of this important chemical. This would be a major factor in lowering the cost of caustic soda production. Another direction in which chlorine utilisation, in the form of hydrochloride acid, could help our country is the conservation of 'sulphur' in the form of sulphuric acid. A number of such uses of hydrochloric in place of sulphuric acid have been suggested (cf., papers 3.11 and 3.19).

Sulphuric Acid

Sulphuric acid is an important raw material for various industries and a very large quantity of sulphuric acid, nearly 50 per cent of the total

Table 2—Comparative Ex. Factory Prices of Alkalies and

Year	Soda ash (Heavy)				Caustic soda (Solid)
	USA	UK	Japan	India without excise	USA
1935	117	108	—	—	262
1940	97	—	—	—	240
1945	97	108	—	220 L	240
1950	128	160	—	330 L	337
1955	145	—	—	334 L	402
1958	170	—	—	370 L	457
1960	170	160	—	370 L	457
1961	170	160	—	400†	457
1962	170*	—	264	400†	457*
1963	170*	190	330	410†	459†
1964	170*	190	—	435‡	460
1965	170	—	—	445‡	460

NOTE—In India prices are controlled

F Fair price fixed by Tariff Board was Rs 533

L Light soda ash

production, is used in the manufacture of superphosphate fertilisers. Unfortunately, sulphur in elemental form is not available in our country. Nearly, 0.28 million tons of sulphur costing Rs 5.42 crores was imported during the year 1964-65. Our future requirements of sulphur in 1970-71 and 1975-76 are estimated to be 1.2 m. tons and 2.0 m. tons respectively. In view of our acute foreign exchange position, this calls for some very bold approach in sulphur substitution and conservation (cf., papers 3.1 and 3.15). The sources of sulphur to which we can look with hope is gypsum and magnesium sulphate from marine sources and sodium sulphate from Sambhar lake bitterns.

The Pyrites and Chemical Development Corporation is establishing a 400 tons sulphuric acid plant in the public sector based on iron pyrites deposits available at Amjor. Large quantities of sulphuric acid is also expected to become available from zinc smelter in Kerala.

Fertilisers

Nitrogen, potassium and phosphorus fertilisers are vital inputs for agricultural production. In India our production of various agricultural products is low necessitating annual imports to the tune of about Rs 200 crores worth of food materials. In view of our increasing population, the situation would become even more serious unless intensive efforts are made to increase the fertility of soil by the use of much large quantities of more efficient fertilisers.

In view of the above, it is a matter of concern that current production (1965-66) of nitrogen fertilisers in this country is not likely to exceed 500,000 tons against the planned target of nearly double this amount. Table 3 shows the indigenous production, imports and future estimated requirements of fertilisers.

Chlorine in Rupees per Metric Ton (Rs 1-0.21)

Caustic soda (Solid)			Chlorine liquid			
UK	Japan	India without excise	USA	UK	Japan	India
—	—	—	220	—	—	—
170	—	—	187	—	—	—
200	—	350	187	—	—	—
380	—	793 F	287	—	—	600
380	—	650	325	360	—	550
—	—	605	325	—	—	437
380	330	—	340	—	330	437
380	330	663	340	360	300	437
—	—	720†	340	—	—	437
366	330	720†	340	340	300	437
—	—	820‡	350	—	280	437
—	—	820‡	275	—	—	—

*Liquid caustic soda Rs 280, light soda ash Rs 52

†Liquid caustic soda Rs 620, light soda ash Rs 20 less/T

‡Liquid caustic soda Rs 720, light soda ash Rs 25 less/T

Table 3—Production and Imports of Fertilisers

Year	N	P_2O_5	K_2O
Production (tons)			
1961-62	144,931	66,022	nil
1962-63	177,785	80,598	nil
1963-64	219,408	107,892	nil
1964-65	233,893	131,547	nil
Imports (tons)			
1961-62	126,432	Nil	—
1962-63	244,500	8,743	47,801
1963-64	221,400	12,200	82,421
1964-65	228,315	11,900	50,758
Future requirements (tons)			
1970-71	2,000,000	1,200,000	500,000

The problem worth discussing at the moment is whether the types of fertilisers being produced or likely to be produced are the ones best suited to the specific requirements of our soils and environments in the light of latest developments. The main form of nitrogen fertilisers are ammonium sulphate, ammonium chloride, mixed ammonium calcium nitrates and phosphates and urea. The comparative efficiency of various fertilisers for different crops is also worthy of our consideration.

Table 4—Imports of Potassium Salts

Year	KCl		K_2SO_4	
	Quantity (tons)	Value (lakhs Rs)	Quantity (tons)	Value (lakhs Rs)
1962-63	77,891	194	3,270	11
1963-64	70,802	169	75,111	182
1964-65	76,524	179	10,240	32

Besides the above, the possibility of adding to the fertiliser activity by organic manures or special plant promotors (e.g. TIBA Tri-iodo benzoic acid, for soyabeans, hormones or mineral nutrients like boron, silicon, manganese, iron and copper etc.) has to be investigated and exploited more fully.

As regards the potassium fertilisers, the picture is rather gloomy as no production has been established so far in this country. The annual present requirements of potassium fertilisers are estimated to be 150,000 tons in term of K_2O. Natural potassium deposits are not found in the country and the only source of potassium is the sea water (cf., paper 3.5). The requirements of potassium fertilisers are, therefore, being met by heavy imports. In Table 4, are given the potassium salts imported within the last three years.

A semi-commercial plant for the recovery of potassium chloride from sea bittern has been set up at Kandla with an annual capacity of 2000 tons. The plant is expected to go in production within the next few months.

Another recoverable form of potassium from sea bittern is schoenite (307) which is a double sulphate of potassium and magnesium. The Central Salt and Marine Chemicals Research Institute has developed a process for its manufacture and has recommended it as a substitute for potassium sulphate fertiliser. However, the effect of a prolonged use of magnesium sulphate on soil fertility has to be ascertained in this connection.

As regards phosphate fertilisers, a problem which should attract our immediate attention is the production of a sample with sufficient assimilable P_2O_5 avoiding the use of sulphuric acid, in view of the lack of sulphur resources in our country. The use of hydrochloric acid for this purpose is being developed already and two new units have been licensed for this purpose (cf., papers 3.2 and 3.14).

Cement

The present production capacity of cement in the country is of the order of 10 million tons per year. Although the planned target for the current plan was 15 million tons but the production capacity has remained almost static for the last 3/4 years. Abundant lime (raw material) deposits are available; therefore, the reason for static production appears to be non-technical. Certain measures like decontrol of cement taken during the last few weeks may lead to an expansion of the production in the near future. A cement corporation has also been set up to establish production of cement in the public sector.

Large quantities of slag are now available from steel plants and can be used in the manufacture of cement. Urgent steps may be taken to establish cement factories using slag as the starting material; this will not only increase the cement production but also conserve the lime deposits.

Marine Chemicals

Sea is an inexhaustible source of practically all the elements that are found in the earth's crust. In this country so far we have exploited sea brine only for salt manufacture. The remaining mother liquor which contains number of other useful chemicals is practically wasted. The important chemicals among these are: (a) potassium salts, (b) bromine, and (c) magnesium salts.

The first important chemical from marine sources is the common salt. We are producing about 40 lakh tons of salt per annum and this production is likely to be doubled by the end of the fourth plan. The present production of salt is more than our requirements and is also being exported. A little effort on quality control will help in boosting up our export of this commodity. The main purchaser of our salt so far, has been Japan and in spite of a competitive F.O.B. value, the actual cost in Japan is reported to be higher. An analysis of the reasons for this type of situation has been attempted in paper 3.6. There is a further scope for export of special qualities of salt to African countries and it is understood that the matter is under careful consideration by the Government.

The problem of a recovery of potassium salts, another important constituent of sea water, has already been dealt earlier.

Bromine is another important chemical which can profitably be recovered from the sea bittern. It is being produced presently at Mithapur. Hundred and thirty-eight tons of bromine was produced in 1964-65 and the production in the current year is likely to be of the order of about 200 tons. Table 5 gives the imports of bromine during the last three years.

Since the production in the country is adequate to meet the present total requirements the Government has already banned the import of this chemical. However, in this connection, it may be worthwhile to point out that the consumption of bromine is likely to increase further due to its use in the manufacture of some organic fumigants and antiknock agents as suggested in paper 3.4. Further requirements of this chemical can also be met from within our internal resources. Simultaneous efforts should be made at National Chemical or some other laboratory to develop processes for the production of fumigants like ethylene dibromide and methyl bromide.

Gypsum is a by-product of marine salt industry and the total quantity of recoverable gypsum is over one lakh ton from the present marine salt

Table 5—Imports of Bromine

	Quantity (tons)	Value (lakhs Rs)
1962-63	207	6.58
1963-64	180	5.50
1964-65	120	4.04

production which is at present 40 lakh tons per annum. Since we have imported one lakh ton of gypsum valued at Rs 35 lakhs from Pakistan during the last year (1964-65), it is obvious that more attention is called for to organise production of gypsum from this source.

Another group of chemicals from the marine sources is magnesium and its compounds. Magnesium metal is required for a number of defence purposes and for preparing certain light alloys required by the aeronautical industry. Attempt should be directed towards the preparation of pure magnesium chloride required in the production of magnesium metal. Another important use of magnesium chloride is in the manufacture of Sorel cement. If this cement is popularised the pressure on the consumption of portland cement can be lessened to some extent.

The other marine chemicals though present only in traces, assume importance due to their current high price. Some work has been started on the recovery of rubidium from sea water (paper 3.4). Work on other basic elements like gold can also be taken up under long range projects.

Miscellaneous Chemicals

Many chemicals although required in smaller quantities are essential for defence and other purposes and it is imperative that we should be self-sufficient in these respects. Some important examples are, aluminium chloride (cf., paper 3.21), sodium hydrosulphide, potassium cryolite, pure zinc oxide, manganese dioxide, acetylene black, active carbon (cf., papers 3.13 and 3.16), activated earth (cf. paper 3.20), ferro and ferricyanides and some electrochemicals (cf., paper 3.9). In addition to the above, attention should be paid to items such as titanium compounds in which we are fortunate in having very rich deposits. Titanium salts (particularly dioxide and to some extent butoxide) are being increasingly employed in paint industry (cf., paper 3.22). In view of its low density and high melting points, metallic titanium was the hope of the aeronautical engineer. Although these expectations have been dimmed to some extent, yet very useful alloys with unparalleled properties could be still envisaged by this so called rare (actually abundant) metal. In view of our very rich deposits, we should, in fact, try to explore even other uses and be leaders in specialised materials of this type so that we are able to export finished products rather than the crude ores particularly in such cases. Similar considerations would apply to thorium, manganese and aluminium compounds.

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3. Shri J. C. Maheshwari, Directorate-General of Technical Development, New Delhi.
4. Dr H. Nath, Directorate of Research and Development, Ministry of Defence, New Delhi.
5. Dr N. N Sharma, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

The information provided by these colleagues has been freely used in the present paper.

4. Drugs & Pharmaceuticals, Medicinal & Aromatic Plants, Public Health Engineering

Introduction

The pharmaceutical industry in the country has made tremendous progress during the last decade and has now reached a stage where we can think of self-sufficiency in the near future, at least in the fields of synthetic drugs and antibiotics. In the preparation of most of the synthetic drugs, however, we are still dependent to a very large extent on imported intermediates. Likewise, many of the raw materials essential for the antibiotics industry are not yet produced in the country. The present emergency has further aggravated the situation because of the severe cut in imports due to the foreign exchange shortage. This difficulty will be with us for some years to come and we have, therefore, to plan to live with it. This materials shortage is a challenge to the resilience of the pharmaceutical industry and to the ingenuity of our research workers to develop the necessary know-how for the production of these items utilising indigenous resources. In the immediate future our main effort has to be channelised in this direction.

As regards the manufacture of pharmaceuticals based on slaughter house products and medicinal plants, and of important essential oils, the position is much worse. In the absence of a well-organised industry for their production a large amount of foreign exchange is being consumed for their import, as will be evident from the import figures given in Table 5. Considering the fact that India is basically an agricultural country it is ironical that we have not achieved self-sufficiency in these items, leave alone the fact that we should have been in a position to earn foreign exchange by their export.

This Get-Together has, therefore, to address itself to (1) Devising ways and means of making available by indigenous production the most urgently needed intermediates and a few essential drugs which have not yet been included in any immediate production plans, (2) Drawing up a list and fixing priorities for those items which for the present will have to be imported, and (3) Evolving a suitable machinery by which continuous contact could be maintained between the pharmaceutical industry, both as individual units and collectively, on the one hand and the research laboratories on the other, so that problems could be more easily identified, their various aspects discussed and then referred to the appropriate laboratory for solution.

Synthetic Drugs

Table 1 gives the present status of the Pharmaceutical Industry, and Table 2 gives the import figures for the year 1964-65 of the major synthetic drugs. These two tables show the shortfalls in the synthetic drugs industry,

Table 1—Present Position regarding the Production of Major Drugs in India

Sl. No.	Item	Capacity in tons as on 1-4-1961	Capacity likely to be installed by 1-4-1966	Approved capacity for IV Plan	Licensed capacity	Shortfall
1.	Penicillin & salts	50	264	250	264	—
2.	Streptomycin	—	190	300	205	95
3.	Tetracyclines	10	139.5	290	244	55.5
4.	Chloremphenicol	10.8	35.8	100	57	43.0
5.	Sulfa drugs	366	465	1500	1000	500
6.	PAS & salts	66	330	1000	530	470
7.	INH	33.4	81.4	450	126	324
8.	Thiacetazone	—	10.0	100	62	38
9.	DDS	18.3	18.3	80	40	40
10.	Halogenated 8-oxyquinolines	80	83.9	200	85	115
11.	Chloroquin amidoquinate	12	39	120	50	70
12.	Tolluitamide	3	43	45	43	—
13.	Aspirin	195	550	1000	560	440
14.	Hetrazan	—	20.6	50	50	—
15.	Phenobarbitone	—	—	20	10	10
16.	Vitamin A	20	25	60	45	15
17.	Vitamin B_1	—	—	75	30	45
18.	Vitamin B_2	—	—	10	5	5
19.	Vitamin B_6	1	1	15	1	14
20.	Vitamin B_{12} (kg.)	5	43	60	43	17
21.	Nicotinamide	43	75	150	88	62
22.	Folic acid	—	—	5	1	4
23.	Vitamin C	—	150	375	140	235
24.	Vitamin D	—	—	1.0	1.0	—
25.	Insulin (m.m.u.)	—	1500	1000	1500	—
26.	Synthetic hormones (kg.)	390	6720	—	—	—
27.	Caffeine	8.26	22	150	22	128
28.	Emetine (kg.)	187	590	250	590	—
29.	Reserpine (kg.)	52	12	50	12	38
30.	Digitalis glycosides (kg.)	—	6	100	106	—
31.	Chlorthiazid	—	—	0.25	—	—
32.	Procaine	—	10	150	—	140

indicating the items needing greater attention, which are given in Table 3, along with the major intermediates required for these drugs. In addition to the intermediates for currently imported drugs, given in Table 3, there are other major intermediates required for the drugs which are already being produced in the country but from the penultimate stages or from imported raw materials; these and other important intermediates needed by the pharmaceutical industry are listed in Table 4.

The basic chemicals which will be needed for the pharmaceutical industry are indicated below, and unless their supply is assured there cannot

Table 2—Import Figures for 1964-65 of the Major Synthetic Drugs

Sl. No.	Product	Qty (in kg.)	Value (in Rs.)
1.	Chloroquine and its salts	—	12,27,639
2.	Pyridoxine (Vitamin B_6)	28,357	19,22,701
3.	Chloramphenicol*	—	25,59,906
4.	Phenacetin*	—	19,07,777
5.	Streptomycin & its preparations*	—	28,15,232
6.	Sulphaguanidine* Sulphamezathine* and Sulphathiazole*	—	50,00,000
7.	Thiamine hydrochloride (Vit. B_1)*	28,357	19,22,701
8.	Penicillin, other preparations*	—	20,23,827
9.	Benzyl benzoate	96,836	5,48,951
10.	Caffeine and its salts	38,315	5,54,973
11.	Camoquin	—	6,07,133
12.	Ephedrine hydrochloride	8,669	5,44,431
13.	Riboflavin (Vit. B_2)*	8,547	19,22,701
14.	Folic acid*	1,233	3,11,967
15.	Nicotinic acid and nicotinamide*	9,445	1,71,296
16.	Para-amino salicylic acid	20,685	3,83,505
17.	Isonicotinic acid hydrazide*	—	2,64,716
18.	Novocaine	8,000	1,21,053
19.	Phenobarbital*	5,772	2,00,000
20.	Pitochin	—	1,28,799
21.	Tocopherols (Vit. E)	2,483	4,48,952
22.	Vitamin D	1,843	1,58,192
23.	Amethocaine hydrochloride	—	25,000
24.	Aminophylline	14,083	20,905
25.	Mephenesin	—	19,969
26.	Pethidin hydrochloride	320	53,485
27.	Phenothiazine	7,066	31,062
28.	Testosterone propionate	—	78,984
29.	Vitamin K*	155	46,999
30.	Acriflavine	61	12,299
31.	Vitamin C	5,958	1,35,197
32.	Vitamin B_{12}	—	1,56,280

*Items which will be produced in adequate quantities by I.D.P.L. or in the private sector

be a sense of self-sufficiency in the field of synthetic drugs. It would, therefore, be necessary to take immediate steps to set up/step up the production of these items. The main point is whether there should be a few large units undertaking the manufacture of these basic raw materials or their production should be dispersed. This Get-Together should give serious thought to these problems.

Table 3—Major Intermediates required for Synthetic Drugs

Sl. No.	Drug	Major intermediates
1.	Pyridoxine	Cyanoacetamide, methoxyacetylacetone
2.	Chloroquin and camoquin	*m*-Chloroaniline, formic acid, diethylmalonate, ethylene chlorhydrin, diethylamine and hydroxylamine
3.	Procaine	*p*-Nitrotoluene, diethylamine and ethylene chlorhydrin/ethylene oxide
4.	Benzyl benzoate	Benzoic acid, benzyl chloride
5.	Caffeine and theophylline	Urea, methylamine, cyanoacetic acid, dimethyl sulphate, formic acid
6.	Pethidin hydrochloride	Benzyl chloride, diethanolamine, thionyl chloride, benzyl cyanide, formaldehyde
7.	Phenothiazine	Diphenylamine and sulphur
8.	Mephenesin	*o*-Cresol and glycol monochlorohydrin
9.	Flaxedil	Pyrogallol, diethylaminoethanol
10.	Radiopaque dyes (Bithgraphin, Urographin)	Benzoic acid, iodine, adipic acid
11.	Halogenated 8-hydroxyquinoline	8-Hydroxyquinoline
12.	Ephedrine	Phenylacetyl carbinol, propiophenone, methylamine, *d*-tartaric acid, bromine
13.	Thiacetazone	*p*-Nitrotoluene, thiosemicarbazide
14.	DDS	Chlorobenzene, aluminium chloride
15.	Neostigmine	Dimethylamine, dimethylcarbamyl chloride
16.	Diphenylhydantoin	Diphenyldiketone
17.	Nitrofuran derivatives	Furfuraldehyde, hydrazine, hydroxylamine hydrochloride
18.	Noradrenalin	Catechol, chloroacetic acid
19.	Amphetamine	Phenylacetone
20.	Cetrimide	Cetyl alcohol, trimethylamine
21.	α-Tocopherol	Trimethyl hydroquinone α-isophytol

Table 4—Main Intermediates required for Essential Drugs

Sl. No. (1)	Intermediate (2)	Qty (in tons/year) (3)
1.	Para-acetamol	40
2.	4-Amino-2, 6-dimethylpyrimidine	50
3.	Anisaldehyde	6·8
4.	*m*-Chloroaniline	103
5.	Phenylethylamine	25
6.	Phenylacetic acid	50
7.	2-Aminopyridine	5
8.	2-Aminopyrimidine	250
9.	Ammonium thiocyanate	200
10.	Hydrazine hydrate and its salts	400

Contd

TABLE 4—*Contd*

(1)	(2)	(3)
11.	Diethylamine	114
12.	4, 7-Dichloroquinoline	50
13.	Diethylaminoethanol	102
14.	8-Hydroxyquinoline or 5-chloro 8-hydroxyquinoline	100
15.	Acrylonitrile	85
16.	Benzyl cyanide	25.5
17.	Cyanoacetic ester	28.5
18.	Dicyandiamide	896
19.	Ethyl orthoformate	90
20.	Diphenyl oxide	186
21.	Diethylethoxymethylene melonic ester	110
22.	4-Diethylamino-3-methyl butylamine	30
23.	L-Glutamic acid	31.5
24.	*p*-Nitroacetophenone	69
25.	β-Picoline or 3-cyanopyridine	250
26.	γ-Picoline or 4-cyanopyridine	565
27.	Acetone semicarbazone	12
28.	*p*-Chlorobenzenesulfonamide	45
29.	2-Chlorophenothiazine	3.6
30.	2-Chloropropyl diethylamine	4
31.	*m*-Xylidine	2
32.	Ergosterol	4
33.	Hydroxymethyl hydrazine	8
34.	2-Methyl-1, 3-propane diol	4
35.	Phenathiazine	3.4
36.	Phytyl bromide	4
37.	Sodium cyanide	15
38.	Proparzyl bromide	10.8
39.	Acetopropyl alcohol	100
40.	Adipic acid	37.5
41.	Benzocaine	50.0
42.	Benzenesulfonic acid methyl ester	64.4
43.	Oxalic acid	306 (5.4 lakhs)*
44.	Lactic acid	45 (1.5 lakhs)
45.	Tartaric acid	459 (14.9 lakhs)
46.	Citric acid	1200 (31.5 lakhs)

*Import value

I. Toluene based chemicals

1. Benzyl chloride. 2. Benzyl cyanide. 3. Benzyl alcohol. 4. Benzoic acid. 5. Benzaldehyde. 6. Phenylacetic acid. 7. Phenylacetamide. 8. Phenyl malonic acid. 9. *p*-Toluenesulfamide. 10. *o*-Toluenesulfamide. 11. *o* & *p*-Nitrobenzoic acid. 12. *o* & *p*-Aminobenzaldehyde. 13. Cinnamic aldehyde.

II. Tar distillation products

1. β and γ-Picoline. 2. Quinoline. 3. *o* & *p*-Cresols. 4. Pyridine 5. Diphenyl.

III. Chlorinated hydrocarbons

1. Ethyl chloride. 2. Ethylene chlorhydrin. 3. Ethylene dichloride. 4. Trichloroethane. 5. Tetrachloroethane. 6. Chloral hydrate. 7. Chloroform.

IV. 1. Chlorobenzene. 2. Di-chlorobenzene. 3. Phenol. 4. Diphenyl ether. 5. Salicylaldehyde. 6. Resorcinol. 7. Coumarin. 8. *o* & *p*-Nitrophenol. 9. *o* & *p*-Anisidines. 10. *m*-Nitroaniline. 11. *m*-Chloraniline. 12. *m*-Phenylenediamine.

V. Amines

1. Ethylamine. 2. Diethylamines. 3. Triethylamines. 4. Methylamine. 5. Dimethylamine. 6. Trimethylamine. 7. Diethylamine-ethanol. 8. Dimethylaminoethanol.

VI. 1. Chloroacetic acid. 2. Dichloroacetic acid. 3. Trichloroacetic acid. 4. Methyl dichloroacetate.

VII. Phosgene

VIII. Inorganic chemicals

1. Cyanides. 2. Thiocyanates. 3. Arsenic and its salts.

IX. Filter paper and filter acids

Till such time as these units are set up, the best way to meet immediate requirements would be for each of the larger units of the pharmaceutical industry to undertake production of some specific items of these raw materials with the research laboratories helping them in the necessary developmental work. However, in the case of certain strategic raw materials and intermediates the National Laboratories and Industrial Research Laboratories themselves should set up pilot plants for their manufacture in order to help the pharmaceutical industry tide over the present crisis. The knowledge and experience gained in the setting up of these pilot plants will be of immense help in the subsequent industrial production of these items.

Suggestions

1. Immediate attention should be given to the manufacture of the intermediates mentioned above, and the items mentioned in Tables 3 and 4.

2. The policy regarding the levy of import duty on drugs and intermediates requires revision with a view to encouraging indigenous production.

3. Research Laboratories should : (i) give top priority to the problems referred to them by industry, develop process up to the pilot plant stage and provide a more or less turn-key job. In the later stages of development there should be closer association between the technical workers of the industry and the research laboratories concerned; (ii) undertake production of the following items in their Pilot Plants :

(a) Benzyl chloride, benzyl cyanide, phenyl acetic acid, phenyl acetamide; (b) *p*-Nitrobenzoic acid, benzocaine and procaine; (c) Ethylamine, diethylamine, triethylamine; (d) Pyridoxine and its intermediates; (e) Tar-rectification to prepare *β*-picoline, γ-picoline, quinoline, *o* & *p*-Cresols; (f) Sodium metal; (g) Sodium cyanide, ammonium thiocyanate;

(iii) in addition produce the following important drugs which are required in small quantity :

(a) Oxytocin; (b) Vasopressin; (c) Polymyxin; (d) 6-Mercaptopurine; (e) Chlorambucil.

4. Certain areas of research which have a direct bearing on pharmaceutical production have so far not received adequate attention in our country. University laboratories and the Institutes of Technology should be requested to concentrate attention on the following fields in order to provide the basic technical knowledge which could eventually be used by industry :

(a) Fluorine chemistry; (b) Organo-phosphorus compounds; (c) High pressure techniques; (d) Acetylene chemistry; (e) Gas-phase reactions; (f) Photochemical transformations; (g) Catalysts.

5. Efforts should be made for indigenous fabrication of specialised pharmaceutical equipment like : (i) High pressure reaction vessels, (ii) Glass rubber lined or plastic reaction vessels, (iii) Industrial size all-glass equipment, and (iv) High vacuum equipment.

Phytochemicals

The import of medicinal and aromatic plants and the products derived from them involves a considerable amount of foreign exchange, as shown in Table 5. The production of phytochemicals and essential oils is largely dependent on a continuous supply of crude vegetable drugs of the proper quality. In spite of the fact that there is a great interest in medicinal plants in this country and the wide variety of climatic conditions offers scope for the growth of different kinds of plants, it is surprising that hardly any attempts have been made for their organised cultivation and the supply of vegetable drugs still depends by and large on wild growth. Since the actual number of plants required in large quantity is quite limited, their immediate cultivation should be undertaken. Once the supply position is assured, entrepreneurs would be forthcoming to undertake their processing for active principles.

Again, consideration has to be given to the problem of exploring alternative natural sources for certain plant products and of finding substitutes for others.

There is now an acute shortage of *Dioscorea deltoidea* tubers which are a source of diosgenin required for the production of corticosteroids and the cultivation of this plant has not been successful. Other Dioscorea spp. like *D. prazeri* which can be easily grown and give good

Table 5—Data on Medicinal

Sl. No.	Product	Source	Import figures (Rs lakhs)
(1)	(2)	(3)	(4)
	MEDICINAL PLANTS		
1.	Liquorice roots	*Glycyrrhiza glabra*	14.00
2.	Pyrethrum	*Chrysanthemum cinerarifolium*	3.50
3.	Digoxin & Digitalis leaves	*Digitalis lanata*	2.60
4.	Ergot alkaloids	*Claviceps purpurea*	4.50
5.	Ephedrine	*Ephedra gerardiana* or synthetic	5.5
6.	Cocoa beans (Theophylline)	*Theobroma cacao*	21.4
7.	Galanga rhizomes	*Alpinia galanga*	2.30
8.	Cocaine & Coca alkaloids	*Erythroxylon coca*	1.49
9.	Atropine salts Belladonna leaves and roots Solanaceous alkaloids	*Datura stramonium* *Atropa belladonna* *Hyoscyamus niger*	0.22 0.44 } 1.03 0.37
10.	Ipecac roots and extract	*Cephaelis ipecacuapha*	1.09
11.	Reserpine & total alkaloids	*Rauvolfia serpentina*	—
12.	Podophyllum resin	*Podophyllum hexandrum*	—
13.	Diosgenin	*Dioscorea deltoidea* and *D. prazeri*	—
14.	Tubocurarine	*Curare*	1.10
15.	Rutin (Vit. P)	*Fagopyrum esculentum*	0.39
16.	Aloes	*Aloe barbadensis*	0.085
17.	Papaverine	*Papaver somniferum*	0.67
17a.	Tannic acid (gallotannic acid)	Gall roots or *Quercus* spp.	0.85
	AROMATIC PLANTS		
18.	Menthol and peppermint oil	*Mentha arvensis* and *M. piperita*	36.0

and Aromatic Plants

Present production (5)	Estimated requirement (qty/acreage) (6)	Remarks (7)
Exptl.	2000 t/2500 acres in Jammu, U.P., A.P., Punjab and Rajasthan	
40 t	300 t/3000 acres in U.P., Kashmir Nilgiris, Assam	
nil	50 t/300 acres in Kashmir, H.P. and Madras	Seeds to be imported
Exptl.	In Jammu	
nil	—	Plant grows scarcely in India—synthetic more economical
Exptl.	900 t/1500 acres in Kerala, Madras	
146.5 t	300 acres in U.P., W. Bengal	
nil	—	Exotic plant—Exptl. cultivation necessary
Exptl.	200 kg./100 acres in Kashmir 30 t/600 acres in Kashmir	*Hyoscyamus muticus* is better source but seeds not available
10 t	45 t/750 acres in Assam, Kerala	
200 t	650 t/4000 acres in Jammu, U.P., Kerala, Coorg	144 t/20.0 lakhs exported
50 t/natural source	900 t/3500 acres in U.P., H.P., Punjab, Kashmir	
20 t/natural source	700 t/1500 acres in U.P., H.P., Punjab, Kashmir	Estimated export Rs 15.0 lakhs
—	—	Substitute is hayatin methiodide from indigenous *Cissampelos pareira*
—	—	Hesperidine from orange peel—good substitute
nil	—	Grows wild throughout India
nil	—	
—	—	Several *Quercus* spp. grow in Indian forests
1.5 t oil	100 t/10,000 acres (menthol) in Jammu & Kashmir, Assam, U.P., Kerala, Coorg	

Contd

Table 5—*Contd*

(1)	(2)	(3)	(4)
19.	Citronella oil	*Cymbopogon winterianus* and *C. nardus*	11.0
20.	Geranium oil	*Pelargonium graveolens*	3.5
21.	Lavender oil	*Lavandula officinalis* and *L. intermedia*	4.70
22.	Davana oil	*Artemisia pallens*	—
23.	Cinnamon, bark & leaf oil	*Cinnamomum zeylanicum*	0.74
24.	Cloves and oil	*Syzygium aromaticum*	33.25
25.	Linalool	*Bursera delpechiana*	1.5
26.	Patchouli oil	*Pogostemon cablin*	2.5
27.	Camphor synthetic	—	5.51
28.	Bergamot oil and other citrus oils	*Citrus bergamia* and other *Citrus* spp.	3.75
29.	Cajuput oil	—	0.61
30.	Dill seed oil	—	0.40
31.	Camphor oil	—	0.10
32.	Cananga oil (Ylong-Ylong oil)	*Cananga odorata*	0.31
33.	Thymol	*Thymus vulgaris*	1.9
	Gums		
34.	Balsam tolu	*Myroxylon balsamum*	0.71
35.	Gum storax	*Liquidamber orientalis*	0.83
36.	Gum benzoin	*Styrax benzoin*	3.66
37.	Gum asafoetida	*Ferula foetida*	31.48
38.	Gum tragacanth	*Astragalus strobiliferus* and *A. gummifer*	2.04
39.	Gum kordofan	*Acacia senegal*	1.10
40.	Gum arabic	*Acacia senegal*	36.80
	Others		
41.	Anisaldehyde (from aniseed oil)	*Pimpinella anisum*	1.46
42.	Wattle bark	*Acacia* spp.	200.00

(5)	(6)	(7)
Exptl.	150 t/400 acres in Jammu, U.P., Coorg, Kerala	
1.5 t	18 t/3500 acres in Kerala, Madras, U.P., Assam, Coorg	
Exptl.	20t/4000 acres in Kashmir, Nilgiris, U.P., Punjab, H.P.	
3 kg.	300 kg./100 acres in Bangalore, Coorg, Kerala	Export 2.25 kg./Rs 2,500
—	—	
—	—	
—	—	
60 kg.	—	Plant susceptible to nematodes—requires investigation
—	—	
—	—	
Exptl.	2 t/100 acres in U.P.	
—	—	
—	—	Exptl. cultivation necessary
—	—	Plant to be introduced
—	—	
—	—	All exotic plants
—	—	
—	—	
—	—	
—	—	
—	—	Experimental cultivation necessary
—	—	
—	—	
—	—	*A. arabica* grows wild in India

yields of diosgenin should therefore be cultivated. Further, certain Solanaceous spp. (*S. aviculare*) are a rich source of steroidal alkaloids which can also serve as starting materials for the preparation of corticosteroids. Sisal is a source of hecogenin, another alternative intermediate for preparation of corticosteroids. The availability and possibility of cultivation of these plants should be immediately explored.

Fagopyrum esculentum is the plant material for the production of rutin, but its availability in the country is poor. It is known that hesperidin, which can be obtained from orange peel has the same physiologicalaction as rutin. Since there is large scale availability of orange peels there is no reason why hesperidin should not be used in preference to imported rutin.

Another example is that of crystalline vitamin E which is being imported to the value of Rs 4 lakhs. It may be worthwhile considering its replacement for most purposes by vitamin E concentrates which can be produced indigenously from rice bran and wheat germ oils, till such time as vitamin E is synthesised in India.

The problem of production of caffeine may also be mentioned here. Although India is one of the largest producers of tea in the world, we are still not able to manufacture enough caffeine to meet our requirements, leave alone for export. A concerted effort is necessary to organise its production. The cultivation of medicinal and aromatic plants has necessarily to be organised on a centralised basis, although actual cultivation may be taken up by various agencies including private enterprise. The Central Indian Medicinal Plants Organisation can and must play a vital role in the organisation of this programme. CIMPO has drawn up a comprehensive scheme for the cultivation of some of the important plants, the implementation of which would go a long way to meet a major portion of our requirements.

Suggestions

1. A list of important medicinal and aromatic plants should be widely circulated to all State Governments and private agencies interested in their cultivation.

2. Phytochemical corporations should be set up in all those states where cultivation and processing of medicinal and aromatic plants is possible. The necessary know-how and material for cultivation may be supplied by CIMPO from their experimental farms.

3. CIMPO should undertake a phased programme of cultivation of plants. In the first phase quick growing plants which would save considerable foreign exchange or are urgently required may be selected :

> (i) *Liquorice*, (ii) *Pyrethrum*, (iii) *Dioscorea prazeri*, (iv) *Claviceps purpurea*, (v) *Ipecac*, (vi) *Digitalis lanata*, (vii) *Mentha arvensis*, (viii) *Mentha piperita*, (ix) *Pimpinella anisum*, (x) *Pelargonium graveolens*, (xi) *Citronella*, (xii) *Lavandula officinalis*, (xiii) *Bursera delpechiana* and (xiv) *Cymbopogon martinii*

The other plants mentioned in Table 5, which are slow growing or of lesser commercial or medicinal importance could be taken up subsequently.

4. A unit for production of vitamin E concentrate from wheat germ and/or rice bran should be set up by industry or in one of the National Laboratories.

5. Import of rutin should be completely stopped and a unit set up to prepare hesperidin from orange peel. Orange oil and pectin would be the by-products.

6. The problem of procurement of adequate quantities of tea dust should be solved and a unit set up near Darjeeling to prepare caffeine.

7. The immediate problems to be tackled by the research laboratories are:

(i) working out a method for the conversion of caffeine to theophyllin

(ii) setting up a pilot plant for the production of gallic acid and pyrogallol

(iii) selection of proper varieties of plants in order to increase the yield of active principles. In this work there could be collaboration with organisations like the Indian Agricultural Research Institute. Some of the specific problems are:

- (a) Increasing the yield of digoxin in *D. lanata*
- (b) Selecting species of Ergot which give low yield of ergetoxine
- (c) Selecting proper species of *Papaver semniferum* which would give good yield of specific alkaloids like papaverine, which is present in low yield in the currently cultivated species

(iv) studying the conditions of storage and preservation of medicinal and aromatic plants in order to find out the optimum conditions

8. Efforts should be made to procure the seeds of the following plants for experimental cultivation through agencies like the UNESCO as the yield of active materials in these species is much higher than in those available in India:

(i) *Duboisia myoperoides*, (ii) *Hyoscyamus muticus*, (iii) *Rosmarinus officinalis*, and (iv) *Cananga odorata*.

Antibiotics and Fermentation Products

As indicated earlier the position in regard to these products is relatively more satisfactory. With the commissioning of the IDPL plant at Rishikesh the country would be self-sufficient. However, a serious effort is required in order to ensure continuous supply of raw materials and in certain cases for finding suitable substitutes. The most important raw materials needed for the production of antibiotics, their availability, and the possible indigenous substitutes are shown below:

	Materials	*Availability*	*Possible substitutes*
1.	Phenylacetic acid	Poor	
2.	Phenylacetamide	Poor	
3.	Phenoxyacetic acid	Poor	
4.	Lactose	Nil	Sucrose and other disaccharides
5.	Dextrose	Poor	Sucrose
6.	Soyabean meal	Poor	Other oil seed cakes

It is obvious that immediate attention should be given to the production of these intermediates for which there can be no substitutes and for carrying out exploratory work for finding substitutes where this seems feasible.

Other important pharmaceuticals based on fermentation are L-lysine, L-glutamine acid, vitamin D from ergosterol and acetylphenyl carbinol (essential intermediate for production of synthetic ephedrine). Development work on these items should be undertaken in the National Laboratories.

Attention should also be devoted to work on microbial transformation which has immense possibilities.

Phenylacetic Acid, Phenylacetamide and Phenoxyacetic Acid

The know-how for the production of these items has already been developed in the country and could be immediately utilised. Till such time as a big unit undertakes their manufacture, the antibiotic factories themselves could set up pilot plant for these items, or one of the National Laboratories should organise production in their pilot plant to ensure constant supply of these essential raw materials.

Lactose. The acute shortage of milk in the country will always present a problem in the large scale production of lactose. Experimental work is necessary for its substitution by other disaccharides.

Diatomaceous earth. The National Laboratories should undertake development of suitable method for the manufacture of this item.

Starch and dextrose. The production of starch from nonstaple foodstuffs should be immediately stepped up. An important raw material could be tapioca and perhaps the water chestnut whose cultivation should be increased. Intimately linked with the production of starch is the problem of dextrose. Its manufacture from easily available sucrose should be seriously considered.

Soyabean meal. Hindustan Antibiotics has to some extent adapted their production programme to the use of indigenously available oilseed cakes. Their data should be made freely available so that other units can also utilise oilseed cake as a part-substitute for soyabean.

Activated carbon. The RRL, Hyderabad, has set up a unit for the production of different grades of activated charcoal. With their large experience in this field it should not be difficult for them to produce products of other specifications to meet any particular requirement of industry.

Ion exchange resins. The NCL and the CFRI have done a considerable amount of work in this field. In order to meet the particular requirement of the antibiotic industries it is suggested that a small group consisting of scientists from these two laboratories and the technical representatives of major antibiotic producing units should draw up the specifications for the resins required by the industry. The import figures of some of the other important fermentation products are:

1. Taka diastase, 0.8 lakh; 2. Lactic acid, 1.5 lakhs; 3. Citric acid, 31.5 lakhs; 4. Tartaric acid, 14.5 lakhs. Effort should be made to undertake immediate production of these items.

Slaughter House and other Animal Products

The import figures of the important materials in this category are as follows:

		Value (Rs lakhs)
1.	Insulin	10.0
2.	Pancreatin	3.0
3.	Bile salts	0.2
4.	Blood meal	0.3
5.	Pepsin	2.5
6.	Egg albumin	0.4
7.	Wool fat	0.5

The preparation of various glandular products has been the subject of a number of reports and schemes, but unfortunately nothing substantial has been achieved. The efficient production of most of these items is linked with the improvement in the quality of animals and the establishment of modern slaughter houses with facilities for refrigeration etc. However, in spite of the absence of such facilities the processing of pancreas can be undertaken for the production of insulin. The glands could be collected and stored in a deep-freeze in existing slaughter houses until required for working up. It is reported that the yield of insulin from the pancreas of Indian animals is too low for its economic production. However, the enzymes pancreatin, trypsin and lipase can also be prepared from pancreas and it is possible that a unit producing all four products may be a commercial proposition. This point requires further investigation.

Slaughter house waste should be fully utilised by stepping up the production of the following items: bile salts like cholic acid and dehydrocholic acid, blood meal and cholesterol.

Lanolin. A large quantity of wool fat is produced in the country from which lanolin can be easily prepared. The production of this item should be immediately taken up.

Vaccine and sera. In spite of the considerable indigenous production of vaccines and sera these are still imported to the value of about Rs 30 lakhs. Most of these imports, however, consist of tetanus and diphtheria vaccines and toxoid whose production could be stepped up. It is also necessary to modernise this industry and to increase the production of newer vaccines like polio vaccine.

GENERAL REMARKS

There is a general feeling among industrialists that the research laboratories have not rendered effective help to industry and that the processes and products developed are often unsuitable for commercial exploitation on account of incomplete data regarding raw materials, equipment and costing. To some extent this charge has a basis, but this ineffectiveness of our scientific research to make an impact on industry should not be attributed to the lack of ability of our scientists but to their inadequate appreciation of the practical problems of industry, due to which their approach, by and large, tends to be academic. On the other hand, industry has become so used to foreign know-how, based on vast technological experience in highly developed countries, that it expects a turn-key job in every case. This is not possible in the present state of our scientific and technological development. There has to be a proper and realistic appreciation not only of the requirements of industry but also of the potentialities and present limitations of the research laboratories. Industry and industrial research have to grow together in the closest collaboration and this requires direct and continuous contact between the industrialist and technologist from industry and the scientist in the laboratories. This Get-Together may suggest a suitable machinery for this purpose.

The drug industry in India markets a multiplicity of basic drugs and formulations, which are essentially similar. While it is a normal feature in a competitive economy for pharmaceutical concerns to sell their distinctive products, in the present difficult economic situation of the country this involves undue wastage of national effort both in their production and their marketing. It would be desirable to introduce some degree of rationalisation by drawing up a preferred list of drugs and formulations, the manufacture of which would only be permitted. A committee of eminent physicians and drug controllers could consider this problem.

The Indian pharmaceutical industry today is by and large not research minded. Although the easy availability of external technical assistance is certainly of immediate advantage to industry, if this knowledge is not integrated with the development of their own technology, the dependence on external know-how for future improvements in products and processes tends to continue. This dependence can be overcome only if industry builds up certain tempo of research which can utilise the provided know-how as a base for further development. It is, therefore, suggested every industrial unit should spend a certain percentage of its total turnover for research. Those units which do not have their own research facilities could sponsor research schemes in various research laboratories or pool their resources to set up cooperative research laboratories.

A programme for biological screening of all compounds synthesised or isolated from natural sources in the country has been initiated by the Pharmaceutical & Drugs Research Committee of CSIR with a view to help in the finding of new drugs. Under this programme centres have been set up for (a) primary pharmacological and microbiological screening, (b) chronic toxicity studies, and (c) clinical pharmacology. As this scheme has been organised mainly in research institutions, experience shows that there is hesitation on the part of private industry to utilise these facilities, as this would necessitate divulging the identity of compounds submitted for screening. It may be worthwhile to consider the possibility of setting up a screening laboratory organised on a commercial basis and financed by the pharmaceutical industry itself.

5. Chemical Plant & Equipment, Electrical & Mechanical Engineering, Agricultural, Textile & Mining Machinery, Automobiles

PLANT & EQUIPMENT FOR CHEMICAL & ALLIED INDUSTRIES

Introduction

Since the dawn of Independence, there has been a concerted effort for the development of Indian industries and a number of projects were initiated both in the public and private sectors. Our Three Five-Year Plans were largely oriented for development through foreign aid and assistance and preliminary plan drawn up for the Fourth Five-Year Plan was largely made dependent on foreign aid. Foreign exchange and foreign assistance have thus formed an important element in the development of these industries. However, it has now become apparent that it is not possible to rely upon foreign assistance in times of need or emergency. The sudden stoppage of outside help could almost cripple our industries and we should therefore, explore all possible avenues for being self-sufficient and self-reliant, as far as our industrial needs are concerned. Self-reliance can be achieved to a large degree only when the entire scientific resources of the country are mobilised for industrial development. The existing industries both in private and public sectors, research organisations and universities have to play a major role for achieving this objective. All the resources of men and materials should be teamed up to conserve the foreign exchange resources by development of indigenous know-how, elimination or substitution of imports and stepping up of our exports.

In the field of chemical and allied industry, the estimated investment for major items during the Fourth Five-Year Plan as worked out by the Perspective Planning Division of the Planning Commission is given in Table 1, which reveals that a total of about Rs 1500 crores will have to be invested, about 60 per cent of which being for the organic based industry. A substantial portion of the total would be in the form of foreign exchange for importing the know-how and equipment for the manufacture of some of the items enumerated in Table 1; certain raw materials also will have to be imported. At the same time, the imports of certain commodities are inescapable—the imports of principal items during 1964-65 were valued at about Rs 960 crores as shown in Table 2.

The objective towards self-sufficiency can be achieved to the extent which the export drive could be accelerated. Estimates worked out by the Perspective Planning Division of the Planning Commission for the Fourth Plan envisage a total earning of Rs 5120 crores, whose details are given in Table 3.

Table 1—Estimated Investment for the Chemical & Allied Industry during the Fourth Plan Period

Industry	Rs crores	Rs crores
1. Nitrogenous fertilisers		191.4
2. Phosphatic fertilisers		69.6
3. Heavy chemicals		159.0
Some of the important items being :		
(a) Caustic soda	38.8	
(b) Soda ash	16.6	
(c) Sulphuric acid	21.6	
(d) Titanium dioxide	11.5	
(e) Potassium chlorate	6.5	
(f) Barium compounds	0.6	
4. Miscellaneous inorganic chemicals the most important of which is oxygen having a value of Rs 12 crores		20.3
5. Organic chemicals		97.0
Some of the important items being :		
(a) Ethyl alcohol	5.6	
(b) Acetic acid	5.2	
(c) Methyl alcohol	8.3	
(d) Phthalic anhydride	8.0	
(e) Caprolactum	7.4	
(f) Formaldehyde	6.1	
6. Derived inorganic products (Cement, Refractories, Glass etc.)		157.9
7. Derived organic products (Dyes, Drugs, Plastics etc.)		248.1
8. Cellulose based industry (Paper, Rayon etc.)		283.8
9. Petroleum (Petroleum refining & petrochemicals etc.)		262.0
TOTAL		1489.1

The enormity of the problem can be assessed by the staggering figures given in the Tables. If the country has to become self-reliant, there is no alternative other than to mobilise all the resources of men and materials and make a concerted effort towards the Swadeshi spirit. Of the numerous papers received for this Get-Together, two of the papers cover the overall picture—one by Dr M. S. Iyengar who has covered the entire requirements including defence and has pointed out the physical gaps that exist in respect of essential raw materials, components and other items; the other paper is by S. Parthasarathi who has brought out clearly the present position and the future requirements of some of the major industries in India. The salient points of the papers received are highlighted below.

Table 2—Imports of Principal Items during 1964-65

	Commodity	Rs crores	Rs crores
1.	Machinery & Transport Equipment		472.7
2.	Chemicals		90.7
	Sodium hydroxide	3.3	
	Sodium carbonate	0.6	
	Carbon black	1.3	
	Sodium compounds	2.2	
	Organic chemicals	20.8	
	Dyeing, tanning & colouring materials	9.3	
	Medicinal & Pharmaceutical products	8.3	
	Essential oils & perfumes	1.0	
	Fertilisers manufactures	25.4	
	Explosives & other chemicals	12.0	
3.	Manufactured goods		221.8
	Rubber manufactures	1.3	
	Paper & Paperboard	13.1	
	Textile yarn, fabric	16.0	
	Non-metallic mineral manufactures	6.9	
	Iron & Steel	107.4	
	Non-ferrous metals:		
	Copper	24.4	
	Nickel	11.6	
	Aluminium	7.2	
	Lead	4.6	
	Zinc	11.3	
	Tin	7.9	
	Manufacture of metals	16.2	
4.	Rubber		5.4
5.	Pulp & Waste paper		8.0
6.	Textile fibres		80.0
7.	Fertilisers, Crude		3.9
8.	Sulphur		5.4
9.	Metalliferrous ores & scraps		2.0
10.	Petroleum crude		27.2
11.	Petroleum products		41.3
	TOTAL		958.4

Table 3—Principal Export Requirements during Fourth Plan Period

	Commodity	Rs crores
1.	Agriculture based exports	3166.36
2.	Hides & Skins undressed	55.00
3.	Woollen	85.23
4.	Mineral ores	656.29
5.	Manufactured goods:	
	(a) Petroleum products	40.91
	(b) Chemicals	45.40
	(c) Leather & leather goods	162.14
	(d) Machinery; electrical including electronic equipment	96.97
	(e) Machinery; non-electrical	87.73
	(f) Miscellaneous	447.60
	TOTAL	5120.28

Highlights of the Papers Presented

Many interesting papers have been received which contain useful points for discussion. The highlights of the papers received are given under the following heads:

Design & Engineering

There are a number of good papers presented on this topic. H. J. Bhabha of Atomic Energy Establishment has suggested the setting up of design and development groups in every manufacturing organisation of sufficient size, so that the know-how in the plant obtained indigenously or under foreign collaboration can be developed further to enable the industry to become independent of foreign collaboration.

Dr A. N. Kapur of NRDC feels that the utilisation of industrial research is hampered due to lack of adequate design and engineering facilities for scaling up of pilot plant work. Another difficulty is the non-availability of proper equipment and machinery in the country. He suggests that there should be close collaboration among the Central Design & Engineering Unit of CSIR, research institutions, equipment manufacturers for the design and fabrication of imported equipment and components.

S. R. Horner of Simon-Carves Ltd, has pointed out the lack of laboratory testing facilities for effluents and the design of effluent treatment plants in India.

M. T. Shah of Indo-Berolina Industries Pvt Ltd, Bombay, has emphasised the great need for developing indigenous design and engineering organisations which can completely handle major projects in the private and public sectors on the basis of indigenous know-how. In case it is not available, necessary process know-how may be purchased.

B. V. Bhoota of Chemical Plant Manufacturers Association of India, Bombay, has rightly pointed that even though considerable know-how has been acquired in the fields of fertiliser, acids and alkalis, petroleum refining, etc., there is still a tendency to import 'turn-key' plants. Consequently, the available facilities in design and fabrication of various equipments are not being fully utilised; thus hampering the overall development of the chemical plant manufacturing industry. He feels that while it is very important to increase the manufacturing facilities in India, it is also essential to build up indigenous facilities for process know-how and design, equipment design and overall plant engineering.

S. R. Poti of Kusum Products Ltd, Calcutta, has suggested that in the fields where indigenous know-how, design, engineering and fabrication facilities are available, the Government should not permit any imports. This will encourage the development of Indian Chemical Plant manufacturing industry.

R. K. Gupta of DCM, Delhi, discusses the importance of indigenous design of chemical plants for optimum import substitution. A high degree of import substitution achieved at a fairly rapid pace by indigenous designing in the field of sulphuric acid and caustic soda plants has been given as examples.

Materials of Construction

Some interesting papers are presented on this topic.

Neyveli Lignite Corporation Ltd have pointed out their difficulties in maintenance of their plants due to nonavailability of imported spare parts. Their efforts at import substitution of spare parts have been hampered due to lack of proper materials of construction. They suggest that CSIR may undertake to study and develop the suitable steels for machinery parts.

N. Thandavan of A.P.V., Calcutta, points out the difficulties in obtaining certified and tested steel plates from the mills and suggests that the steel mills could make available through their stockyards materials of specified categories in thicknesses of common usage to approved specifications.

V. A. Altekar of Department of Chemical Technology, Bombay, has suggested much wider uses of aluminium as a material of construction in chemical plant manufacture due to its remarkable properties.

Regional Research Laboratory, Hyderabad, have developed enamels for glass-lining of mild steel equipment. They have been able to glass-line vessels of 8 and 22 litres capacity and mention that they are in a position to successfully fabricate the glass-lined equipment in the near future.

K. Seshadri of CSMCRI, Bhavnagar, has studied corrosion problems in marine atmosphere and has found suitable inhibitors and coating agents for mild steel.

H. V. Shah and D. J. Mehta of CSMCRI, Bhavnagar, have developed efficient insulating materials from magnesia and calcium silicate.

S. L. Chawla of IIT, Delhi, has brought out the importance of titanium as a material of construction in industry and defence and suggests setting up of a plant near Alwaye for production of 5 tonnes of titanium ingot per day using the ilmenite sand as the raw material.

Fabrication

There is only one paper on this subject. O. P. Kharbanda of Larsen & Toubro Ltd, Bombay, has surveyed the development of chemical plant manufacture in India, giving the existing facilities, missing links, and future requirements. He is confident that given the necessary incentive and facilities for expansion, the industry will grow at a phenomenal rate.

New Processes

There are a number of papers under this category.

M/s Voltas have suggested that research in the field of refrigerant gases be conducted to make the Indian air-conditioning industry self-sufficient.

V. A. Altekar of Department of Chemical Technology, Bombay, has recommended implementation of some of the processes developed by the CSIR for import substitution. Specific mention is made of the development work done by NML for the low carbon ferro-alloys, which can be exploited.

D. S. Datar of CSMCRI, Bhavnagar, and his associates have taken up much needed studies on desalination of sea and brackish water by using the solar energy and humidification and dehumidification techniques. Based on experience gained on 500 gallons per day capacity solar still, cost estimates of various sizes of plants have been made. Comparative cost studies of various methods of desalination have also been carried out.

N. Krishnaswamy of CSMCRI, Bhavnagar, has indicated the application of ion exchange resins and membranes for reducing the salt content in natural waters. Indigenously prepared ion exchange membranes are proposed to be used for desalination of Rajasthan brackish water.

New Equipment

S. D. Mehta of Gujarat Refinery Project, Baroda, considers that the various types of trays used in the distillation columns can be easily manufactured in India.

R. P. De of Bengal Immunity Research Institute, Calcutta, has stressed the need to develop various types of specialised equipment required by the Pharmaceutical industry in India. He also suggests the manufacture of materials of construction like stainless steel, high density polythene, PTFE, etc.

V. N. Lele *et al.* of CSMCRI, Bhavnagar, have taken up the design of various continuous type equipment like draft tube extractor, flotation cell, centrifuge etc. useful in the recovery of chemicals from sea and inland brines.

R. N. Vohra and B. G. Thaker of CSMCRI, Bhavnagar, have developed a machine for making pipe insulation sections using 85 per cent magnesia obtained from bitterns and asbestos. The machine suitable for small scale industry is being fabricated in the Institute, which does not require any imported components.

R. P. Dhiman of CSMCRI, Bhavnagar, has designed and fabricated a mechanical salt harvester having a capacity of 10 tonnes/hr. Work has been started for the design of a mechanical soil stabiliser to raise the bearing strength of the soil to 3 kg./cm.^{2}.

D. S. Datar and associates of CSMCRI, Bhavnagar, have developed a disperse salt washing column for producing industrial grade salt from Kharaghoda salt.

M. A. V. Devanathan *et al.* of CECRI, Karaikudi, have worked a new manganese dioxide cell to substitute the Leclanche Cell. The developed cell does not require any imported component.

P. B. Mathur *et al.* of CECRI, Karaikudi, have developed three types of high power batteries which are required for defence purposes.

Miscellaneous

L. N. Misra of NMDC, Jhunjhunu, has pointed out the difficulty created by blind insistence on B.S. specifications for materials like winding rope for shaft sinking and mining even though indigenous ropes fabricated with higher factor of safety are available.

S. D. Gomkale and R. L. Datta of CSMCRI, Bhavnagar, advocate the use of sea water as coolant in industries located near the sea-coast, to effect water conservation. Remedies to overcome the corrosion problem in such use have also been discussed.

H. V. K. Udupa of CECRI, Karaikudi, while appreciating the phenomenal growth of lead-acid storage battery industry in India, has referred to considerable research work carried out at CECRI to improve the performance of various types of batteries.

N. C. Mehta of Union Carbide, Calcutta, describes the research and development methods used in the dry cell industry and mentions that local sources have been developed for manganese dioxide, chemicals etc. which have substantially reduced foreign exchange needs of the country. Defence requirements have been met by the dry battery industry.

D. Krishnamurthy of Union Carbide, Calcutta, points out the necessity of conservation of zinc in the battery and transistor industry. It has been mentioned that batteries and transistor sets are being re-designed to maximise conservation of foreign exchange. It is suggested that the design of batteries for civilian use may be made keeping defence specifications in mind.

R. M. Khandwala of Union Carbide, Calcutta, has drawn the attention towards the conservation of spare parts used in organic chemical plant by (i) effective preventive maintenance, (ii) salvaging of spare parts by metalising, metal locking etc., (iii) standardisation of equipment so that the inventory on spares is reduced, (iv) replacement by indigenously fabricated spares etc. Practical methods for the achievement of the above objectives have been indicated.

Recommendations

In view of the big gaps existing between the requirement and the present position, top-most priority should be given to develop processes and products of defence requirements, imports substitution and export promotion.

In the case of a chemical industry, there are a number of essential pre-requisites like process know-how, process engineering, project engineering and fabrication facilities with all types of materials of construction required for the chemical industry.

Following are some of the recommendations made by Convener and the Convening Committee:

Where know-how is not available indigenously, it should be imported, particularly for basic chemical industry. While importing the know-how from a foreign licencee, a Design Organisation should be associated and agreement be arrived at so that the designing is done indigenously in collaboration with a licencee.

It should be possible to arrive at a satisfactory agreement with the parties having the know-how or the licencees of the process, either by outright purchase or on telescopic rates. It may be necessary to import the know-how for basic industries like ammonia, nitric acid, urea etc. on this basis.

In passing, it may be mentioned that the nitric acid and nitro-limestone plant at Rourkela was built on this basis of collaborative design with imported know-how.

At all stages it is essential to associate a Laboratory that has facilities for doing the type of work involved in the process imported, which would enable the Laboratory to develop the indigenous know-how in course of time so that our country could become self-reliant.

Where the industry is existing in India and enough experience has been gained in running the industry, it is not necessary to import the know-how unless it is distinctly superior. For duplicating the existing plants, it should be possible to come to an agreement with the licencees.

Where the know-how is available on a Laboratory or a pilot plant scale, in the Laboratories of the CSIR or of any other organisations like Universities, Defence Research Laboratories, private industry etc., a laboratory, a design organisation and an industry should join up as a team with joint responsibility and put up either a semi-commercial or a commercial plant.

The patent for the process, if any, should be given exclusively to the industry cooperating for the exploitation of the process, the process know-how and the engineering developed forming the property of the three parties.

For any further exploitation of the process, the three parties will be involved and the licence fee should be shared by the three parties.

In the case of a process, where the process details are available on laboratory scale only but requires further development on a pilot plant scale or a semi-commercial scale, the laboratory, the design organisation and the industry should take it up as joint responsibility. For the exploitation of the process on a commercial scale, the procedure mentioned above may be adopted.

If the industry takes the initiative of sponsoring their problems to be taken in a research organisation, the subsequent exploitation becomes easier, but once again the laboratory, the industry and the design organisation should work the entire project to the logical end of its exploitation on a commercial scale.

The part that the engineering and design organisations have to play in the industrialisation of the country is quite considerable. A number of such organisations are already existing in India, both in the private and public sectors. Some of the engineering organisations in private sector are: Simon-Carves, Power Gas Corporation, Humphreys & Glassgow, Dastur & Co., Bechtel India, DCM, Dorr-Oliver, Larsen & Toubro etc.

Some of the engineering organisations in the public sector are the Central Design & Engineering Bureau at Ranchi; Planning & Development Division of the Fertiliser Corporation of India, Sindri; Fertilisers & Chemicals, Travancore; the Technological Consultancy Bureau of the National Industrial Development Corporation, New Delhi, and the Central Design & Engineering Unit of CSIR, New Delhi.

In view of the important role that these Design & Engineering organisations have to play, their number in public sector is thoroughly inadequate. The existing organisations should be strengthened both in personnel and facilities and some more started. It may be advantageous to organise the Design & Engineering Units in specialised fields like Fertilisers, Ferrous Metallurgical industry, Non-ferrous Metallurgical industry, Inorganic Chemicals, Organic Chemicals, Pharmaceuticals, Petroleum & Chemicals etc. These Design & Engineering Units should be made to take the responsibility on the basis enumerated above.

One of the important requirements of chemical industry is the availability of fabrication facilities for the manufacture of equipment of various types with a variety of materials of construction for various operating conditions. Some facilities do exist in India both in private and public sectors for the fabrication of chemical plant and equipment. In the private sector, some of the well equipped units are A.V.B., Larsen & Toubro, K.C.P., Binny Engineering, Port Engineering, A.P.V., Walchand Nagar Industries, etc. In the public sector, the Heavy Engineering Corporation at Ranchi, the Coal Mining Machinery Project at Durgapur, Heavy Electrical Project at various places, Hindustan Machine Tools etc. have up-to-date facilities for fabrication. Strengthening of the existing units in both sectors may be necessary so that they are fully equipped for the fabrication of all types of equipment with various materials of construction.

In addition to the existing facilities, some more workshops for fabrication of specialised items as recommended by the Working Group for Fertiliser and Chemical Equipment with a capacity of 10,000 tonnes per year on single shift basis may be started.

One of the most important aspect of chemical industry is the use of various types of materials of construction. Some of the important materials available in India are mild steel, cast iron in various grades, aluminium, copper to a very limited extent, wood, acid resistant bricks, tiles, and cement etc. Facilities are available for fabricating and lining of equipment and accessories with lead, rubber, PVC, polythene etc. Some stainless steels and alloy steels are being planned to be produced shortly in India. However, in view of the enormous requirements of the various types of materials required for chemical industry, steps may be taken to:

(a) increase the production of stainless and alloy steels .
(b) increase the production of copper
(c) set up production of nickel and its alloys
(d) augment glass-lining of equipment
(e) produce industrial plants in borosilicate glass
(f) start graphite industry for chemical plant manufacture

Contribution of CSIR

Process Know-how

The various laboratories of the Council of Scientific & Industrial Research have been contributing their mite for the development of know-how for a number of processes. The programme of the laboratories have been re-oriented giving higher priorities to the development of defence-oriented projects, import substitutions/elimination, export promotion, food & agriculture, industrial products and processes etc. A comprehensive list of research project for 1965 being worked in the various laboratories is available as a separate publication.

The process know-how is generally developed on a laboratory scale and wherever it is found to be economically feasible, the work is continued on a pilot plant scale. In some cases the work is carried out in production-cum-prototype plants and the products are regularly marketed. The object of running the production-cum-prototype plants is not only to collect technical and economic data but also to study the marketability of the product. Examples of such type of plants are Optical Glass Plant at the Central Glass & Ceramics Research Institute, Calcutta, Synthetic Tanning Materials (Syntans) at the Central Leather Research Institute, Madras, Pig Iron from Low Shaft Furnace at the National Metallurgical Laboratory, Jamshedpur, and the Low Temperature Carbonisation and the Active Carbon Plants at the Regional Research Laboratory, Hyderabad.

Design & Engineering

The laboratories connected with the Chemical and Allied products have well-staffed chemical engineering and mechanical engineering divisions to look after the design, fabrication, erection and running of the pilot plants. The technical and economic data required for upscaling the plant are also collected. The chemical engineering and mechanical engineering divisions also design and develop individual equipment required for the industry. Some of the examples of development of equipment in the various laboratories are Ice Flaking Machine at CMERI, Durgapur, Salt Harvester at CSMCRI, Bhavnagar, the pneumatic-cum-mechanical Cleaning Unit for Cotton Seed and the Belt Conveyer type Cleaning Unit for Vegetable Oilseeds at the Regional Research Laboratory, Hyderabad.

The Central Design & Engineering Unit was recently started with the object of filling the gap between the pilot plant and the commercial plant by the exploitation of the processes completed in the national laboratories. The Unit is growing in strength and a number of projects are under its anvil. A number of private and public sector organisations have been assisted in terms of the supply of designs and drawings, assessment of performance data etc.

All the details and designs have been completed for the production of Magnesium Metal on a semi-commercial plant having a capacity of about 250 tonnes per year based on the process developed by the National Metallurgical Laboratory, Jamshedpur. Similarly, based on the process know-how available with the Regional Research Laboratory, Hyderabad, designs have been completed for the equipment to produce three organic chemicals —Metanilic Acid (1800 tonnes/year), Meta-aminophenol (750 tonnes/year) and Paraaminosalicylic Acid (200 tonnes/year) and in collaboration with one of the engineering firms; they have been tendered for M/s Hindustan Organic Chemicals Ltd.

The Unit has also assisted in the re-designing of the prototype plant for the production of potassium chloride at Kandla having a capacity of about three tonnes per day. The plant is expected to be commissioned by the beginning of next month and when it goes into production regularly, it would save about Rs 2.00 lakhs per year of foreign exchange.

A number of projects of strategic importance or import substitution are being worked out, the chief among them being:

1. Complete plant and equipment for metallic sodium
2. Equipment required for aluminising steel wires
3. Plant and equipment required for the manganese production, etc.

Industrial Collaboration

Plans are ahead for indigenous designs for a low temperature carbonisation plant of 900 tonnes per day capacity with the know-how and design data from a firm in Germany having considerable experience in this field.

Similarly the possibility of importing the know-how and design data from other countries is also being explored wherever such know-how is not available in India.

It is hoped that the Central Design & Engineering Unit and similar organisations in India will have ample scope to play their legitimate role in the industrial development of the country.

ELECTRICAL & MECHANICAL ENGINEERING

India's vast resources of land, labour, minerals, water, power etc. promise a great future. Yet at the end of the Third Plan, the much sought after 'take-off point' in the national economy appears elusive. The gap between the advanced countries and India has in effect been widening, unlike the case of a host of other nations, the Russians, the Japanese, the Chinese, or even the Egyptians. Each one of them is effectively closing this gap, while India appears to be sliding backwards with shortages in food, inflation in money, and a general flagging of the economy. For these over-bearing problems now confronting the country, if there is a solution, it lies only within the horizons of Science and Engineering.

It is not enough to launch Five-Year Plans, or merely project crores and crores of investment. Such investments can help, as they actually have helped up till now, monetary inflation. Inefficient utilisation of large capital spendings with inadequate outputs and slow rate of implementation can bring no other results. Each industrial investment must be a sound, scientific, and economic proposition not only when it is effected but in the foreseeable future as well. This implies more than mere planning. This implies research for continuous development of technology.

Indian industry is basically licensed industry. Initially, for immediate industrialisation, there was and could be no other choice. A broad enough base has now been established in the past 18 years, of a very wide variety of heavy, medium and light industries spread all around this sub-continent. It is time for an assessment of the licence biased industry and the continuing dependence on foreign know-how.

After these many years of working licensed industry, the cost of indigenous products continues to be unduly high and their quality poor. The reasons are much too apparent. The cost of setting up industry with imported technical know-how is far greater than setting up the same industries in developed countries. Most expensive is the delay between the time when expenditure has begun to be incurred till the industry's wheels get going. Added to this, the uneconomic usage of the plants with relatively inexperienced managements and operators results in high cost as well as poor quality of indigenous goods both in Public and Private sector enterprises. The listed price of indigenous products does not reveal their true cost to the consumer. Life expectancy may be less than half that of the imported components. Not only therefore is the true cost double, the consumer demand is doubled too, causing artificial market scarcity. This is so far true for almost all indigenous products, motor cars, scooters, refrigerators, electrical appliances, steel or steel products. Under this apparent mask of industrial expansion, shortages grow and inflation increases. The intrinsic values have, and continue to escape notice.

Those who have been responsible for working licensed industry, have found that many of the licensed products or processes do not cater to our particular needs. Even the vastly different practices, for example, between the British and the American industry can often be explained by saying that each is doing a sensible thing in its own circumstances. The first requirement of a licensed product is its adaptation to Indian environment. This calls for indigenous research and development. And once research is commenced, with the basic level of technical know-how already obtained under the licence, indigenous talent will begin on the cycle of further discovery and innovation, of producing more with less efforts, at less cost, of replacing imported materials by indigenous materials, of so called radical discoveries, new products and processes. It should therefore be a necessary condition of setting up licensed industry, that commensurate expenditure on research and development sections is simultaneously planned and carried through, either by the industry itself or cooperative research. When resources are meagre, the need is all the greater to harness technical ingenuity through organised research and development.

The example of all countries that have made rapid progress within the past two decades is clear. Most striking is the example of Japan. Building largely on available technologies, Japan has generously piled funds and efforts towards self-sufficiency, which has brought Japan now to a leading position as the most formidable competitor of advanced countries.

Japan has worked no miracle. It is well known that economic growth in the highly industrialised countries in the world is due entirely to advanced scientific research and technological developments. The expenses on research are deliberate and sustained. As an index it is useful to note that the USA and USSR spend over 3 per cent of their national income on research and developments, whereas India is hardly reaching the level of 0.32 per cent. Considering also the comparatively smaller size of Indian national income, the total expenditure on research is insignificant. The research output is also therefore less than meagre.

Yet in another sense, in paying consultation fees, royalties, technical fees etc., this country has paid heavily towards research expenditure abroad. The experts estimate that the total payments far exceed the target of 3 per cent, only these have not sustained Indian Science. By a conscious effort, these payments must now be increasingly diverted to indigenous research where the returns will be far greater.

The use of science and technology is, from one point of view, simply the exploitation of the natural resources of brains to overcome the deficiency in other resources. In this sense, exploitation of brains is the necessary condition for increasing prosperity in a country which has large unexploited reserves of materials and labour. And India compared to China, Japan, or Russia is in no way inferior in its resources of brains. What is grossly lacking in India is, in one simple expression, the lack of a science-oriented policy. We plan, no doubt, to spend on industry, on agriculture, power, irrigation, etc. crores of rupees, giving inadequate allocations to research and development, which alone can ensure that these crores shall continue to bring in desirable financial returns.

It was generally believed in the past in the West, and is still believed in India, that scientific research cannot be planned, and increased allocation cannot decide the rate of growth and discoveries. It was considered that discoveries are unpredictable and cannot be foreseen or planned for. This is true. But what this truth hides is the other, more important fact, that though the actual discoveries could not be predicted, their rate and number is determined by the funds made available and number of scientists employed. Further that the discoveries or improvements in technologies will be mostly in the field in which the funds and scientists are deliberately diverted. These two truths are demonstrably employed by other nations with clarity of action and positive achievements to their credit—and in the particular fields desired !

The Central Mechanical Engineering Research Institute, Durgapur, pursuing specifically the new policies of the Director-General, Scientific and Industrial Research, has within a short period demonstrated effectively what could be achieved through organised research, and how immediately the national economy may be bolstered through increased investment in science. The impact of research investment on economy, especially flagging stagnating economy, is far greater than that of any other investment, both as regards immediate returns as well as future recurring savings. A few case histories illustrate this.

Cable making machines were hitherto imported. The requirements of imports of these machines in the Fourth Plan are Rs 24 crores in foreign exchange. The progressive management of Hindustan Cables Ltd embarked upon collaborative research with CMERI for the indigenous development of cable making machines. The inexperienced, but qualified staff of CMERI formed the central point of development, obtaining guidance from experienced technical hands of the Hindustan Cables who have years of experience with similar machines imported from many different countries. The engineers of the interested indigenous manufacturers, were also brought in to form a complete team. With the keen vigour of the young scientific staff, the constant encouragement of the experienced Hindustan Cables' executives, and the all out efforts of the indigenous manufacturers, Kumardhubi Engineering Works and Mc Nally Bird, the prototypes of some machines are already working. In the global tender opened by Hindustan Cables last month, Rs 1.76 crores worth of CMERI designed machines have been tendered. Another Rs 40 lakhs worth are to be tendered by February 1966. These cable machines have 98 per cent indigenous content, and as delivered to Hindustan Cables, they are lower in cost than the imported machines. An estimated Rs 15 crores of foreign exchange can be saved within the Fourth Plan on cable-making machines alone. Indeed after this demonstration of past efforts, funds and facilities would have to be admitted for such research.

Another striking example is the research undertaken for savings in steel for structures. CMERI's structures, designed and fabricated from most readily commercially available sections of angles and bars only, have returned in every case economies of over 30 per cent in steel compared to conventional designs. These fully welded open web designs comply with ISI specifications. They also lend themselves ideally to techniques of mass manufacture. The combined efforts of the Regional Engineering College staff and CMERI, with regular exposures to the experienced structural engineers of Kumardhubi Engineering Works, Jessops, and Apeejay Structurals, have brought forth perhaps the most impressive and far-reaching economies, in the structures already supplied/erected.

Nationally applied, a total saving of Rs 200 crores is not outside the scope of this research programme, representing 1.5 million tonnes of saving in steel worth Rs 120 crores. This could in fact be a saving in foreign exchange since Rs 500 crores worth of steel is expected to be imported to meet the gap between demand and supply of steel during the Fourth Plan.

Besides these two examples there are numerous other research projects with CMERI in various stages of completion, including those for indigenous scooters, tractors, turbine pumps, automobile radiators, automotive filters, refrigeration plants, industrial ice-flaking machines, shear-punching machines, electronic comparator, electronic balancing machines etc., aiming similarly at many crores of savings in foreign exchange during the Fourth Plan itself, besides generating effectively self-sufficiency through self-reliance.

In all these projects the young, keen, qualified, though relatively inexperienced scientists, are combining their talents with the experience available within the country in the manufacturing units, with actual users, the University professors, or visiting experts. In substance it is simply that if there are young minds engaged in scientific work, and if objectives and targets have been clearly laid before them, given reasonable facilities, their performance and output would more than equal national aspirations.

The papers received for this Get-Together highlight the deficiencies in many areas from which a list is made at Annexure I as immediate tasks. The problem resolves mostly to that of equipment design, or material substitution. The capacity to manufacture, with a few exceptions only, is for most part available now within the country. This is especially true of general engineering, electrical engineering, chemical plants, end textile machinery.

The multiplicity of specifications forced on the country by innumerable collaborations originating from all parts of the world, has presented great difficulties. Rationalisation could reduce this problem to manageable dimensions and indigenous substitution would become commercially feasible. The papers make valuable suggestions. A few alloy steels could cover the requirements of a very wide variety of slightly differing specifications. Copper, zinc, lead, stainless steel are replaced by aluminium in many applications. Similarly, PVC and polystyrene linings could replace stainless steels, paper insulation, and lead linings etc.

A start having already been made, the entire range of wire and wire rope, and cable-making machines should be developed, since they imply allied techniques.

Food preservation requires extensions of refrigeration engineering in a big way. Cold storages, refrigerated trucks and wagons, ice-flaking machines, freeze drying etc. involve research programmes within the capacities of indigenous talent. Only funds and facilities have to be provided.

Equipment for hygienic and automated slaughter houses ranks high in priority. It would not only provide crores worth of presently imported essential by-products, medicinal/industrial chemicals and fertiliser, but also conserve fodder against fast depleting resources and reserves.

Agricultural machinery including improved implements is an essential pre-requisite for increased food production. The range of equipment must also cover pumps, gassification tanks, insecticide sprayers, hullers, millers, grain polishers, decorticators, etc.

Testing machinery for laboratories, colleges, and industry form essential requirements that must be covered to ensure a firm base for the steady development of technology in the future. Industrial electrical testing equipment development must receive greater attention.

Mining equipment manufacture could now be met from indigenous capacity, but indigenous spares for existing imported machinery require to be urgently developed.

High pressure pumps are an urgent need for ammonia and some other chemical plants, and must be developed for indigenous production.

A very large drain on foreign exchange is due to automotive spares, since the vehicle population grows incessantly. Many individual enterprises have been set up whose work, through judicious coordination, could be scaled up for country-wide exploitation. A similar approach is warranted for other machinery imported in large numbers, such as heavy earthmovers, excavators, graders, etc.

In all these efforts for import substitution valuable assistance could be provided by Directorate-General of Technical Development and other Organisations by way of Technical Information Centres which hold and disseminate data on the up-to-date indigenous availability of capacity in ancillary industries. Technical liaison is deficient both in industry and in research institutes. Very little is indeed known of the work under progress in the laboratories from which the industries could derive direct benefits. Adequate expenditure for the organisation of effective Technical Liaison & Information Services is very essential with the present need to harness available resources of know-how and capacities.

Pointed attention is drawn to the wastefulness of turn-key contracts awarded to foreign contractors. Insistence on using indigenous materials is largely ineffective, since the foreign contractors' natural desire is to rely upon maximum of imported materials. If instead, turn-key jobs, wherever possible, are entrusted to the Indian contractors, the maximisation of indigenous utilisation of products and technology would result along with decreasing dependence in foreign know-how and imported materials.

With proper links effectively forged, between CSIR laboratories, other laboratories in the country, and the private/public sector industry, the Fourth Plan could largely be fulfilled with the limited foreign aid now expected, provided the problems are approached with determined action of the Government which alone can provide this crucially urgent leadership. Annexure II outlines a few of the areas surveyed in which drastic reductions in foreign exchange are possible for the Fourth Plan, totalling approximately Rs 900 crores. As confirmed also by the Spengler report of US experts, the Indian engineering industry today is *not* working beyond 25-30 per cent of its installed capacity. Thus increased indigenous manufacture in replacement of imported goods would throw upon it a load that it can absorb, leading to better economic returns from investments. Most of the industry is working one shift only, and in some cases 1½ or 2 shifts. Indigenous designs and indigenous materials are urgently required through a concerted indigenous scientific effort. The country could only then look forward to fully self-sustaining economy before entering the Fifth Plan—provided the Fourth Plan is from now on, adequately research-oriented.

In the end, it is to be recognised that given all the keen talent, the total research output is limited by the number of qualified men, the equipment, and the funds piled into developmental research. In a country as vast as India, with a complex of private and public sector enterprises spread all around the country, the Central Government effort ultimately can only form a small part of the total research and developmental effort. Each leading industry, public or private, must organise and establish its own research and development cells which can collaborate between themselves and with the other established institutes. A sizeable research and developmental effort in the country can be organised only in this manner leading to a self-generating economy with continuing advancements, year after year.

ANNEXURE I

The need for the undermentioned is stressed:

1. Rationalisation of differing specifications for materials
2. Cable-making, wire & wire rope machines
3. Economical structures
4. Warehouse designs
5. Refrigeration plants, cold storages, refrigeration transport
6. Freeze drying
7. Substitutes for Freon gas
8. Meat processing equipment
9. Tractors and implements
10. Hullers, millers, grain polishers, decorticators
11. Pesticide pumps, water pumps, minor irrigation machinery
12. Testing equipment for laboratories, Universities and Industry
13. Spares for mining industry
14. Spares for automotive industry, and transport vehicles
15. Spares for earthmoving, grading and road-making machinery
16. High pressure pumps for chemical plants especially ammonia
17. Polymers as substitutes for stainless steels, zinc, lead etc.
18. Polymers to substitute paper insulation in cable industry
19. Combustion studies for power plants
20. Acoustic burners
21. Pulsating combustion devices for high heat release
22. Aluminising plants
23. Mopeds
24. Silicon carbide, high temperature semi-conductors
25. Brake linings for automobiles
26. High voltage porcelain shells of larger dimensions
27. Nickel and tin free bearings
28. Filters, industrial and automotive
29. Shear punching machines
30. Pneumatic hammers
31. Hydraulic presses of high capacity
32. Cooling towers
33. Heat exchangers, especially high pressure
34. Metal finishes as protective coatings
35. Precision machine tools, and instrument making machines
36. Fluxes for welding

37. Continuous welding machines
38. Mobile cranes
39. Fluid couplings and torque converters
40. Utilisation of industrial waste heat

ANNEXURE II

The following are the principal reasons why imports have been heavy in the past besides the crave for imported items and facility of getting turnkey jobs:

(i) Ease with which foreign exchange has been made available to the public/private sector industry. The only difficulty has been in completing paper formalities and paper checks.

(ii) Lack of knowledge with purchase organisations regarding what is available in the country. There are no reliable directories or purchasers guides available in the country, while new industries are coming up all the time all around this sub-continent.

(iii) Lack of available designs to load up spare capacities,and lack of design development organisations both in the public and private sectors.

(iv) Lack of emphasis on indigenous research and a drive to develop or utilise Indian technology, or rely upon Indian engineers.

If examples explained in the paper are extended by forming active teams and team leaders—not part time Study Groups—and tasks assigned, engineers/scientists are available with CSIR, public and private sectors, who can reduce the foreign exchange requirements to at least the extents shown below. A nation-wide survey through nominated team leaders could reveal much greater scope for use of indigenous capacity, indigenous materials and indigenous technology, of which everyday commendable examples at the level of individual entrepreneurs are seen ever since present foreign exchange crisis has occurred.

The foreign exchange savings can be divided into two groups, viz. Capital Investment and Maintenance Imports.

Capital Investment in Fourth Plan Industry

(Rs crores)

	Item	Estimated investment		Possible savings
		Total	F.E.	F.E.
1.	Iron & steel, steel ingots, finished steel, pig iron	1082	457.5	200
2.	Alloy, tool and stainless steel	114	54	20
3.	Aluminium	140	65	20
4.	Non-ferrous—Cu, Zn, Pb	76	28	8
5.	Steel structurals	38	12.75	3
6.	Cranes	10	2	6
7.	Cast iron rolls	15	5	4
8.	Road rollers	2.5	0.5	0.5
9.	Other road & construction equipment	10	4.0	2.0
10.	Motor cycles & scooters	7.5	2.5	1.75
11.	Auto ancillaries	25	8	5
12.	Tractors	23	9.5	7
13.	Cables & wires	65.5	24	15
14.	Fertilisers	306.3	134.4	50
15.	Petrochemicals	121	56.3	25
16.	Paper & pulp	150	55	25
17.	Synthetic fibres	50	20	5
18.	Coal production	185.35	51	15
19.	Iron ore	50	16.5	6.5
			TOTAL	415.85

Maintenance Imports

		Saving (Rs crores)
1.	Steel (from 500 crores)	120
2.	Alloy steels NML/CMERI/ASCON (from 150 crores)	10
3.	Aluminising instead of galvanising (even if aluminium is imported)	10
4.	Fertilisers, Potassic (from 58 crores)	15
5.	Fertiliser nitrogenous by shift of emphasis (from 134 crores)	30
6.	Rayon pulp, paper pulp (from 69 crores)	20
7.	Automobile, motor cycle, scooters (from 182 crores)	60
8.	Auto-spare parts & equipment for garages (from 40 crores)	10
9.	Railways (from 100 crores)	20
10.	Components for machinery industry (from 561 crores)	110
11.	Maintenance spares for machinery industry (from 360 crores)	65
12.	Hides and skins	5
	TOTAL	475

A saving of Rs 475 crores in maintenance imports is not a difficult task considering that the Fourth Plan estimate of such imports is estimated at Rs 5500 crores.

Thus from preliminary surveys an approximate total saving of foreign exchange of Rs 415.85 crores in capital and Rs 475 crores in maintenance imports, i.e. a total of app. Rs 900 crores is not beyond the capacity of properly harnessed available indigenous talent. This makes it possible to run the industry another shift with the far-reaching and self-multiplying cycle of economic benefits.

MEETING OF WORKING GROUP 6

6. Food, Agriculture, Fish, Meat, Sugar, Tea, Coffee Oilseeds, Edible Oils

WHY THE FOOD CRISIS ?

Introduction

As things stand, India is short of approximately 6 million tons of food per year, costing about Rs 3,500 million. In order to overcome this shortage, two lines of action are necessary.

The first one is to prevent heavy losses which occur due to rodents, insects, and micro-organisms, and also due to defective methods of processing, handling and distribution. It is estimated that these losses amount to approximately 50 per cent of the food raised in the country (Table 1) and are valued at Rs 46,000 million, which is twice as much as the Central Government's budget. Scientific methods to prevent these losses have been developed, but they need to be utilised in a very effective manner. Proper machinery must be set up without further delay to apply these methods on a nation-wide scale. If this can be done, India will become not merely self-sufficient but surplus in food.

The second line of action would be to produce more food, not necessarily by increasing the acreage under food crops but by raising the yield per acre through better use of water resources, improved seeds, modern fertilisers, and plant protection. At the same time, we must search for new sources of food and feed. This would indeed be a long-term effort but should be given its due importance.

An attempt has been made in this paper to discuss only the first aspect, as it falls within the purview of the CSIR research programme and can lead to a much quicker solution of the food problem.

Preventable Losses

Losses due to rodents. It is estimated that India has a rodent population of at least 2,400 million. Some of the surveys indicate a population as high as 5,000 million. These rodents cause tremendous losses during pre- and post-harvest periods when the crop is still in the field. Six rats eat food equivalent to the calorie requirement of one human being. Assuming that only half the food consumed by the rodents is fit for human beings, they destroy at least 25 per cent of the food raised for human consumption. The estimated value of food lost due to rodents is Rs 16,500 million.

The solution of this problem requires concerted scientific research and immediate application of the available means for extermination of the rodent population throughout India. Success cannot be achieved in this field of work unless it is carried out simultaneously at the district, state, and national levels. A National Rodent Control Committee was appointed

Table 1—Preventable Losses of Food

(Percentage of harvest)

Loss in	Cereals	Pulses	Oilseeds	Fruits and vegetables
Field	25	25	25	25
Storage	15	20	10	35
Transport	3	3	3	
Processing	7	20		
Quantity (million tonnes)	37.5	8	3	8
Value (million Rs)	22,500	6,400	3,000	4,000

about 6 months ago. Realising the urgency, we hope the Committee will meet soon.

Storage losses. Losses due to insects, rodents and micro-organisms during storage are estimated to be at least 20 per cent on a very conservative scale. Immediate steps should be taken to prevent these losses. The CFTRI has done a considerable amount of useful work in the field of infestation control in warehouses which could be immediately applied to prevent losses occurring in cities. These preventable losses may be as high as 5 to 5.5 million tonnes, their estimated value being Rs 3,000 million to Rs 3,300 million.

The storage capacity of the Central and State Warehouses must be increased from the present level of 1,000,000 tonnes to at least 10,000,000 tonnes. This would result in a saving of 1,500,000 tons per year, and would also give the government a firm grip on the trade in foodgrains. As 70 per cent of the foodgrains are consumed and stored in rural areas, extension work through C.D. agencies is essential. There should be at least one Infestation Control Officer in each district.

If infestation control is to be undertaken on a large scale in India, the following insecticides and rodenticides will be required in large quantities—methyl bromide, ethylene dibromide, lindane, malathion, barium carbonate, zinc phosphide, and some others.

The first four are being manufactured in very small quantities, or not at all. On the assumption that only the marketable surplus of 30,000,000 tonnes of food would have to be treated, the production and turn-over of each plant would be as follows :

	Quantity (tonnes)	Value (Rs)
Methyl bromide	5,500	5,500,000
Ethylene dibromide	5,500	5,500,000
Lindane	15	450,000
Malathion	15	250,000

Losses in handling. The greatest loss of fruits and vegetables occurs during the picking, handling, and transport of these commodities. The losses are estimated at 5 to 6 million tons (one-third of the harvest). If the fruit growers could be induced and trained to adopt correct procedures—such as careful picking and handling, packaging in polythene bags or in crates, using baskets which would not crush fruits, application of insecticidal sprays and fungicidal skin coatings—much more valuable food would be available for consumption in the fresh state, and even for export.

Increasing Food Supplies

Milk. The milk production is estimated at 24,600,000 tonnes in 1964. The requirements, based on the modest ration of 10 oz. per person per day, is about 60,000,000 tonnes. The main problems that have to be solved to produce more milk are: (i) consolidation of small holdings, (ii) disposal of surplus cattle, and (iii) better management of land. Solutions are known, but it is a matter of regret that they are side-tracked.

Plant protein from oilseeds and legumes can be suitably processed and added to milk so as to double the available supply. A variety of baby foods, weaning foods and high protein foods that are being imported at present can be produced. It is even possible to manufacture a spray-dried milk powder from groundnut milk or soya milk.

Fish. The food supply can be increased greatly by increasing the catch of fish, which at present is about 1,000,000 tons. About 10 per cent of this is converted into fish meal, because it cannot be processed or transported quickly enough to consumption centres. Should the attempts at deep-sea fishing with motor driven boats prove successful, the fish preserving industry will have to increase its capacity very rapidly. This will mean, mainly, rapid increase in ice production, cold storage facilities and refrigerated trucks and railway wagons. Indigenous methods, such as sun-drying, can also be improved and extensively used, if need be.

New sources. Green leaves have been used only to a very limited extent for human consumption (spinach, salad). They contain 2 to 3 per cent by wt of good quality protein. Simple methods of extraction and preservation of leaf protein have been worked on wastes, certain weeds (like water hyacinth), and fodder crops (lucerne or alfalfa) economically by these methods. Similarly, a study is being conducted at the CSMCRI on the cultivation and utilisation of sea weeds, as human food and cattle feed, as well as for producing alginates, alginic acid, and agar agar which are being imported.

There are dozens of species of plants whose seeds can yield oil, protein, and perhaps some essential oils and medicinal substances. They are being used here and there on a small scale. Though their usefulness on a local scale cannot be doubted, the possibilities of commercial exploitation have yet to be ascertained. For example, the possibility of having large palm plantations may be examined more closely, as we imported 31,100 tonnes of palm oil at a cost of Rs 34.4 million in 1964-65.

Technological Development of the Food Industries

The food industries constitute one of the largest groups among Indian industries (Table 2). This is so in spite of the fact that a large part of food processing is done in units that are too small to figure in the statistics.

Table 2—Statistics of

	Class of industry	No. of factories registered
1.	Dairy products	8
2.	Canning & preserving of fruits and vegetables	22
3.	Canning and preserving of fish and other sea foods	3
4.	Grain mills	464
5.	Bakery products	21
6.	Sugar and gur	234
7.	Cocoa, chocolate and sugar confectionery	8
8.	Miscellaneous foods	1251
9.	Vegetable and animal oils and fats	14
10.	Distilling, rectifying blending of spirits	33
11.	Wine industries, breweries and malt manufacture	7
12.	Soft drinks and carbonated water	11
	TOTAL	2076

The major defects to be remedied are: obsolete machinery and processes; poor maintenance of machinery; non-recovery of by-products. The efficiency of operation and level of technological development vary widely from sector to sector.

Grain mills. For example, among the grain mills, the wheat milling industry consists of a few large mills with modern machinery and a high degree of efficiency. The rice milling industry consists of a large number of small units (43,500 in 1963) out of which only 416 figure in the statistics. The average recovery of head rice is between 62 and 68 per cent while in USA and Japan, the recovery is between 70 and 72 per cent. Thus, the avoidable loss of rice during milling is about 2,000,000 tons, valued at Rs 1,200 million.

Very few of the mills bother to extract oil from rice bran, or even to stabilise the bran by drying. The annual collection of rice bran in the rice mills is estimated at about 1,000,000 tonnes; less than 10 per cent of this is extracted for oil, and converted into a high grade cattle feed. The number of even moderate sized dal mills is negligible. The loss of dal during milling is believed to be much larger (20 per cent) than that of rice (7 per cent).

Oil mills. The position in the oil milling industry is much the same. There are only 14 large factories, which may be assumed to be working with some efficiency. Most of the oil is extracted in 'ghanis' and 'chukkis' which yield oil of low quality, and a very crude cake. Oilseeds constitute the greatest single reservoir of protein foods in India (Table 3). Even if half of them are processed carefully so as to produce meal fit for human consumption, protein intake of each Indian would increase by about 7 gm./day.

Fruits and vegetables. Similarly, the fruit and vegetable industry, which also has a large number of small units, does not try to recover and exploit its by-products. For example, pectin is being imported at a high price, whereas the industry could meet a large part of its requirement by recovering pectin from waste materials such as citrus peel and pomace, and the like.

Food Industries 1962

No. of factories reporting	No. of persons employed	Productive capital (Rs million)	Gross output (Rs million)	Value added by manufacture (Rs million)
7	1,955	32.70	82.20	11.30
22	5,823	85.30	56.80	16.40
3	422	1.80	10.70	3.10
456	41,556	148.80	1076.10	69.30
20	5,117	38.90	99.80	31.50
232	126,292	1347.90	2156.20	433.40
8	932	6.90	15.30	4.10
1163	208,544	1422.80	3760.90	566.90
12	1,878	21.30	173.00	8.40
33	4,098	41.50	39.80	11.00
7	1,698	30.10	36.20	12.10
10	695	10.00	18.00	7.70
1973	399,010	3188.00	7525.00	1145.20

Table 3—Edible Oilseeds in India, 1964-65

	Production ('000 tonnes)	Percentage	Oil content ('000 tonnes)	Percentage	Protein content ('000 tonnes)
Groundnut kernels	4,340	40	1736	26.7	1,130
Sesame	466	43.3	202	18.3	85
Rape & Mustard	1,375	39.7	546	22.0	302
Copra*	250	63.1	157	6.8	17
Cottonseed	2,000	18	360	16.0	32
Linseed	380	40	142	25.0	95
TOTAL	8,811		3143		1,661

*Figures for 1963-64

The fruit and vegetable industry should be encouraged to take over production of a certain part of the raw material it requires. It would then acquire some control over the quality as well as the price of the fruits and vegetables that are processed. Having both the capital and know-how, it would be in a position to increase productivity of market gardens and orchards tremendously.

Machinery. The losses during milling and processing can be attributed to lack of proper machinery, or to obsolete and worn-out machines which have reached the stage of least economic returns. Modernised machinery not only offers better prospects of increasing productivity, but will also place our products at par with those of the advanced countries. They will then bring in greater export earnings.

In view of the foreign exchange difficulties, it is necessary to step up the designing and fabrication of the machinery indigenously. The various laboratories of the CSIR should take the initiative in this matter. The 'know-how' thus acquired could be provided to the industry for commercial scale fabrication. For instance, industry immediately needs drum driers, spray driers, bin driers, bottle washers, vacuum concentrators, distillation equipment, various types of filtration equipment, new type of grinding and mixing equipment, new types of centrifuges, pineapple sizing and coring equipment, better and efficient milling machinery for cereals, filling and sealing machines etc.

Packaging materials. India imported 52,416 tons of tin plate worth Rs 51,455,850 in 1964-65, and it is expected that the requirement of tin will double by 1970-71. It would be appropriate to look for alternative indigenous materials for containers. Cans made of aluminised steel plate, or aluminium itself, can be used for many types of food products. Use of flexible material (polythene, aluminium foil) and glass should be encouraged wherever possible. The use of glass for processed food is at present at a very low level. Perhaps it can be stepped up.

Defence requirements. The Indian army has to fight and survive in terrain which was considered uninhabitable till now. A number of special foods have to be developed and produced on a large scale. The demands are exacting: ease in handling and preparation, light weight, weather-proof packaging, long storage life. Post-war developments in dehydration and packaging are so far advanced that most of these requirements can be adequately met. However, much spade work remains to be done before a sufficient number of dehydration plants can be set up to satisfy the needs of the defence forces.

Exports. It is not commonly realised that more than one third of India's export earnings (Rs 268.8 million in 1964-65) come from food products (Table 4). The principal items are tea, coffee, oilseeds and oilcakes, fruits and vegetables, cashewnuts, spices, and sugar. If the industry could derive the full benefits from available knowledge and expertise, it would improve its economic status and export performance considerably.

The import of food articles is shown in Table 5.

Collaborative Effort needed

In order to make a concerted attack on the food problems enumerated in this paper, the CFTRI has formulated approximately 100 short and long range research and technical development projects. Most of the projects are inter-disciplinary covering the fields of: Biochemistry & Nutrition, Cereal & Confectionery; Food Engineering & Process Development; Experiment Stations; Fruit & Vegetable Technology; Industrial Research, Consultancy & Extension Service; Infestation Control; Meat, Fish & Poultry Technology; Microbiology; Protein Technology; Spices & Flavour Technology; Applied Nutrition & Dietetics; and Training programme. In spite of this, it has not been possible to cover every aspect of work to solve the problem.

Therefore, an effort is being made to obtain the collaboration of other laboratories. For example, there is a collaborative research project on cottonseed with RRL, Hyderabad; and a new project is being formulated with CLRI on processing of meat and meat products. Problems in the field of mechanical engineering are already under discussion with CMERI and RRL, Bhubaneshwar. It is hoped that close collaboration will also be worked out for production of chemicals required for rodent and insect control with the National Chemical Laboratory, the Regional Research Laboratory, Hyderabad, and the Indian Institute of Biochemistry and Experimental Medicine. A collaborative research project has been formulated with CBRI to develop suitable structures for foodgrain storage under Indian conditions.

Table 4—Food Exports, 1964-65

	Item	Production ('000 tonnes)	Quantity exported ('000 tonnes)	Value (Rs million)
1.	Coffee	60.0	30.7	134.2
2.	Tea	373.7	216.0	1246.6
3.	Oilseeds, nuts & kernels	8583.8	15.76	20.1
4.	Vegetable oil	—	44.7	70.5
5.	Oil cakes	—	1262.8	397.0
6.	Sugar	3185.0	217.2	197.9
7.	Spices	504.8	53.3	167.6
8.	Cashewnut	142.0	56.6	290.3
9.	Fruits & vegetables	18000.0	—	77.3
10.	Fish	1500.0	19.9	67.9
11.	Others	—	—	19.0
			TOTAL	2688.4

Table 5—Food Imports, 1964-65

	Item	Quantity ('000 metric tons)	Value (Rs million)
1.	Dairy products & eggs	—	103.2
2.	Fresh & simply preserved fish	14.6	32.1
3.	Cereals	—	2080.0
4.	Cashewnut	192.0	164.4
5.	Dates	72.0	36.4
6.	Other fruits and vegetables	—	55.7
7.	Cloves	0.6	4.3
8.	Copra	63.0	64.4
9.	Mutton tallow	52.0	5.6
10.	Palm oil	31.0	34.4
11.	Vegetable oils & fats	—	13.6
12.	Others	—	8.5
		TOTAL	2602.6

Conclusion

It would seem reasonable to conclude that while basic studies on carefully identified problems must go on in the laboratories as before, a very special effort must be made to raise the technological level of the food industry. A much larger industrial consultancy service, supported by documentation and publication units, will be needed.

The CFTRI budget for the Fourth Plan period has been provisionally put at Rs 68,200,000, which includes Rs 8,500,000 for ten experiment stations, Rs 5,600,000 for industrial research and consultancy service, and Rs 3,750,000 for the training programme. The average expenditure of Rs 13,640,000 is only one three-thousandth of the annual loss of food.

There should be no need to emphasise that any measure to increase the food production, or to utilise the existing food supplies more fully, is of prime importance to the safety and welfare of the nation. The economy cannot really become self-generating until the food deficit is converted into a food surplus. Concerted efforts have to be made in many directions before this can be achieved.

Immediate action required on following points:

1. Rodent control programme
2. Disposal of surplus cattle
3. Infestation control in warehouses
4. Industrial production of insecticides
5. Manufacture of spraying and fumigation equipment
6. Design and fabrication of machinery for food industry
7. Substitutes for tin plate
8. Production in CSIR labs of
   - (a) Insecticides: Methyl bromide, ethylene dibromide, lindane, malathion, pyrethrum
   - (b) Machinery: Drum dryers, spray dryers, rubber rollers for grain mills, seed cleaners, etc.
   - (c) Aluminised tin plate
   - (d) Materials required for defence forces

FISH TECHNOLOGY EXPERIMENT STATION
C.F.T.R.I.
MANGALORE.

7. Metallurgy, Iron & Steel, Non-ferrous Metals

The present emergency has brought to the forefront the problem of meeting the requirements of strategic defence and other high priority industries of important metals based on indigenous resources. It needs little emphasis to state in the present context that high priority should be given to the exploration of suitable ore resources, immediate follow-up action in the development of already proved reserves and establishment of production units (even on pilot scale where necessary) so that our requirements are met partially if not wholly at an early date.

The problems of iron and steel industry centre mainly round the raw materials, their characteristics, production technology, skill of operational personnel, utilisation of the plant's full capacity, mechanical maintenance etc. It has been conclusively established that beneficiation of raw materials is indispensable on metallurgical and economic desiderata.

The main problems before the iron and steel industry of general interest on which continuous and detailed investigations are necessary, include beneficiation of raw materials such as iron ore, limestone, coal etc., indigenous production of ferro-alloys and all refractories etc. It is heartening to note that most of the currently recognised techniques of improvement in iron and steel production technology including sintering, pelletising, oil injection, continuous casting etc. are being given due consideration in our Iron & Steel Plants both in the private and public sectors. The acute shortage of alloy steels has been felt for quite sometime in the country in the light of negligible indigenous production so far. However, though belatedly, it is now understood that the Government is expediting the production plans for alloy steel manufacture in various integrated steel plants as also in the Durgapur Alloy Steel Plant and Mysore Iron & Steel Works, in addition to giving top priority to the commissioning of alloy steel plants in the private sector, in view of defence and other essential industrial requirements under the present emergency.

The metals that need heavy usage today are aluminium, copper and zinc. These three metals are needed in large quantities and considerable progress has been made in the production and planning of production capacity for aluminium; however, the projected copper and zinc production has not materialised so far and it is imperative that recognising the present chronic shortage of foreign exchange, urgent and immediate steps are taken to (i) procure concentrates of zinc from abroad, (ii) produce concentrates from our own resources in Rajasthan, and (iii) get the projected plants of copper and zinc at Zawar, Khetri, Visakapatnam and Kerala established in the near future.

In addition to copper and zinc, it is imperative that secondary refining capacity of non-ferrous metals in short supply should be set up. Throughout the country public opinion should be created to part with old and redundant utensils of brass and bronze available in millions of households, which could then be remelted and utilised for various important defence and strategic uses.

Regarding utilisation of all sources of scarce metals such as copper and zinc apart from secondary refining, the huge quantities of zinc from dross generated during galvanising have also to be reclaimed. In this connection, it may be mentioned that the National Metallurgical Laboratory has developed a process for the distillation of zinc from the galvanisers' dross and based on these investigations, the Indian Tube Company and TISCO are shortly to put up dross distillation plants thus enabling recovery of large quantities of zinc.

There is no production of primary tin in the country; hence the recovery of tin from the scrap assumes importance. In this context, the National Metallurgical Laboratory has developed a process for the recovery of metallic tin by electrolytic detinning from tinplate scrap.

Chromium, vanadium, nickel, cobalt, magnesium, etc. are not being produced. Antimony metal is being produced from imported concentrates. There is no production of zinc metal; zinc concentrates are exported to Japan in exchange for import of zinc metal and tin requirements are being met entirely by imports.

In view of continued scarcity and known inadequate resources of various metals like copper, zinc, nickel, tin, tungsten, molybdenum, cobalt, etc. the National Metallurgical Laboratory has been endeavouring through its research and development programme to explore the possibility of substitution of these metals partially or where feasible, wholly with such metals as are available from indigenous resources, e.g. aluminium, manganese, chromium, etc. in various applications. A comprehensive report on the subject covering wide range of applications in ferrous and non-ferrous metals and alloys where indigenous substitute metals and alloys can be used was submitted to the Metals Committee of the Council of Scientific & Industrial Research by Dr B. R. Nijhawan and Shri K. N. P. Rao in June, 1963.

The National Metallurgical Laboratory has right from its inception, embarked upon some major research and development themes on substitute alloys and alloy steels, such as the nickel-free austenitic stainless steels, low alloy high tensile structural steels, indigenous tool and die steels, iron-aluminium alloys, nickel and cobalt-free electrical resistance alloys, nickel-free coinage alloys, manganese bearing substitute brasses, aluminising of steel, aluminium based substitute alloys for the production of diverse ranges of end products to exacting specifications and practical needs.

There are other metals which though needed in smaller quantities and with lesser indigenous resources but of strategic importance, such as tungsten, lead, cadmium, antimony, nickel, molybdenum, magnesium, titanium, calcium, barium, strontium, germanium, selenium, beryllium, and the like.

Studies on small scale production of magnesium metal by silicothermal reduction process at the National Metallurgical Laboratory have resulted in the formulation of the Project for a semi-commercial scale plant for production of 250 tonnes/year of magnesium metal at Jamshedpur from indigenous raw materials with design and setting up of the plant in collaboration with Central Design & Engineering Unit of the Council of Scientific & Industrial Research and the National Metallurgical Laboratory with technical know-how from the National Metallurgical Laboratory developed process.

The importance of titanium metal and its alloys in modern jet aircraft manufacture and chemical industry should give an impetus to the utilisation of our considerable resources for setting up a pilot plant for its production initially to meet immediate requirements of these industries. The National Metallurgical Laboratory has already done some work on titanium production by Kroll's process and in case a pilot plant is set up, can train up Indian Scientists and Technicians which at a later date may assist in the commercial scale production plant.

The National Metallurgical Laboratory has undertaken a long range research programme on the development of technique and production of ferro-alloys from indigenous raw materials. High and low-carbon ferrochrome, carbon-free ferrochrome, ferro-aluminium etc. have been produced on tonnage scale for the first time in India. Besides, the Laboratory has produced ferro-tungsten, ferro-titanium, nitrided ferro-alloys etc. by alumino-thermic process.

This sustained painstaking research and development work has resulted in the projected setting up of the plant for integrated ferro-alloy production at Durgapur. In addition, production of ferro-alloys by alumino-thermic processes developed by National Metallurgical Laboratory has been taken up by certain private sector parties also.

With the steel ingot production in India reaching the higher targets as formulated under the successive Five-Year Plans, there will be a corresponding rise in the demand for refractories which form the backbone of iron and steel as well as metallurgical, glass and ceramic, cement and kiln brick industries. A large number of refractory products such as magnesite, chrome-magnesite, mullite, zircon, sillimanite and carbon refractories and carbon and clay bonded graphite crucibles have been developed utilising indigenous raw materials. A party has since commenced production of graphite crucibles based on the NML developed process.

In view of the increasing requirements of the above minerals and metals in the country and with given resources, it is to be emphasised that speedy efforts be made by the Geological Survey of India and the Bureau of Mines to prospect various areas where such minerals are indicated. The Government of India should with cooperation of State Governments assist where necessary the private lessees of various reserves to produce the required quantity of ores and concentrates. Wherever any ores have to be tested for beneficiation etc. speedy action is required to get the samples sent to the National Metallurgical Laboratory for beneficiation where a fully integrated Pilot Plant to obtain technical, operational and economical data on mineral beneficiation is available as also for any further studies for recovery of the metal under reference.

In view of the shortage of primary metal, steps should be initiated to utilise the drosses and related residues from metallurgical wastes such as zinc dross from galvanising shops, aluminium dross, brass dross, reclamation of lead and processing of electro-metallurgical residues and muds.

The Steel Cost Committee is going into the question of reduction of steel production prices. In the case of aluminium metal production, the high cost of certain imported raw materials such as cryolite, aluminium fluoride besides high cost of electric power stand in the way of reducing the production cost, which is estimated to be about 30 to 40 per cent higher in the country at present compared to world production costs. Petroleum coke is partly available indigenously from Gauhati refinery.

The problem of potential substitution in all fields will cover a wide spectrum. With a view to focussing attention on multitudinous aspects of 'Metallurgy of Substitute Ferrous and Non-ferrous Alloys' a Symposium is being organised by the National Metallurgical Laboratory in March 1966, the deliberations of which, it is hoped will go a long way towards implementation of projected needs of the country.

About 35 papers have been received for presentation and discussion in this Working Group on Metallurgy, Iron & Steel and Non-ferrous Metals. Summary of the salient points only made by the authors includes the following :

In the field of minerals, ores, metals and alloys, India's drain on foreign exchange annually is of the order of 100 crores of rupees. This calls for an immediate enhancement of production of minerals and ores by 50 to 100 per cent, which may imply an increase in the exploration effort to the extent of 100 to 200 per cent. This must be coupled with the establishment of an adequate number and variety of metallurgical plants capable of processing the raw minerals and ores within the country itself. Transportation, port and other ancillary facilities need also be developed simultaneously.

A brief examination of the mineral provinces of India indicates that by and large, this country is reasonably well-placed in the matter of natural resources. A concentrated and integrated programme of exploration using geological, geophysical and geochemical techniques is required. Applied research towards design and manufacture of geophysical equipment, development of field methods and interpretation techniques, offshore geophysics, ore genesis and other allied fields need also to be taken up at the same time.

The items which are of general interest to the entire iron and steel industry, on which a continuous and detailed investigation is necessary are as follows :

(i) Beneficiation of raw materials for the iron and steel industry, such as iron ore, limestone, coal, etc.

(ii) Pre-reduction of iron ore

(iii) Indigenous production of essential ferro-alloys and other materials including certain grades of refractories

(iv) Research on substitution of materials for imported products both as raw materials and finished products

(v) Corrosion problems faced in the coke by-product units of the Iron & Steel Works, etc.

Once these problems have been clearly spelt out, it should be possible to set up task force to devote full attention to specified areas of work. This could be on a regional basis, so that concentrated efforts can be put in by the industry and the national laboratories to achieve the objectives in the shortest possible time.

It has been suggested in a paper from CFRI, that reserves of prime coking coal in India being meagre compared to the vast reserves of iron ore, every effort should be made for its conservation both in production and its use. Steps that are necessary in this regard are:

- (a) Upgrading of inferior coals by washing
- (b) Blending of inferior qualities of coking coals and adopting of techniques like selective preparation, stamped charging etc.
- (c) Economising the use of coke in blast furnace by fuel injection, use of self fluxing sinter, high top pressure and controlled humidity of blast
- (d) Increasing the availability of coke by using coke size down to 20 mm.
- (e) Use of medium temperature coke from poorly coking or non-coking coals in low shaft furnace for the production of iron.

Of these, the washing and blending of coals are now adopted in the country, but improved preparation techniques for blending of sub-standard coals are yet to be adopted. Adoption of measures for economising the use of coke which is also being aimed at will go a long way in conserving our limited resources of prime coking coals.

In another paper from CFRI, it has been stated that on the basis of investigation undertaken at the Institute regarding the possibilities of using Talcher seam coals for the production of low ash and low phosphorus coke, the Industrial Development Corporation of Orissa initiated detailed investigations to explore the possibilities of preparing low ash, low phosphorus and reactive coke (char) for the manufacture of ferro-chrome in Orissa State by utilising the Talcher coals which are already relatively lower in ash and phosphorus.

Similarly, one lot of low ash and low phosphorus coke was prepared by CFRI for Messrs Birla Brothers with a view to assessing the possibilities of their use in calcium carbide manufacture. Although encouraging results were reported, the project has not been seriously pursued up till now as low ash coals are not readily available in the market.

Thus, cleaned coal of the required quality either of coking or non-coking type when carbonised in an appropriate plant will yield coke or char that can be successfully used for the manufacture of both calcium carbide and ferro-alloys.

Full scale medium temperature carbonisation tests on both washed and unwashed Orissa coals show that these coals can be successfully processed in narrow continuous vertical retorts similar to those installed at the Central Fuel Research Institute for the production of semi-coke suitable for low shaft furnace and other metallurgical uses. The physical and chemical properties of the semi-cokes were found to be ideal for use in low shaft furnace for pig iron production.

Foundry and Iron Castings

It has been pointed out in a paper from Union Carbide of India Ltd, that the steel castings industry in India, which is greatly dependent on the import of carbon and graphite electrodes, should till the foreign exchange position improves or local manufacture commences, consider substitution with ductile iron (S.G.) castings. The paper further analyses the scope for these castings to bridge the gap between demand for high-duty casting and available supply. It points out that ductile iron castings can be produced without any additional investment to existing foundries and that dependence on foreign exchange for this industry can be substantially reduced.

A paper from Messrs Electro-Steel Castings Limited has suggested that steel plants require regularly Alloy Steel Castings for maintenance as well as for expansion, usually these parts are being supplied from imports. If a committee is formed of the Steel Plant Engineers and the Furnace Designers and the Alloy Steel Casting Suppliers, we can easily develop these items without importing.

Alloy Steels

Messrs Voltas, in a paper, have stated that whilst plans to set up alloy steel plants are underway and the requisite know-how is presumably available for a number of the more common alloy steels, indigenous research and development should be carried out or suitable collaboration sought, to manufacture the following types of steels, which are, in a number of cases known under brand names:

1. 'MAN-TAN' (100,000 lb. p.s.i. tensile steel used for heavy construction equipment)
2. Tungsten Carbide Steels
3. 'Nimonic' Steels
4. Nitriding Steels
5. Forging Steels
6. Stainless Steels
7. Steels for Armour Plating

A review of the steps to be taken to make our country self-sufficient in alloy steels, should be undertaken by the Metallurgical Committee of the Council of Scientific & Industrial Research.

Attention has been focussed on this issue from the point of view of engineering product manufacture. It is considered however, that TISCO would be in a better position to enlarge and make a comprehensive note on this most important issue.

Hindustan Aeronautics Ltd, Bangalore Division have stated their interest on the development of Raw Materials for the Aircraft Industry—especially the aluminium alloy sheet stock and special steels. The industry, in general, would be satisfied if our development work is rationalised and centre round two or three types of alloys. It is understood that in USA among the C.M. steels used in aviation SAE-4130 and SAE-4140 figure most similarly 24 ST among aluminium alloys.

Conferences of this nature were organised in the past by the DTD & P (Air) with the Director-General of Civil Aviation and Ministry of Defence. A close follow up of the decisions then taken and if actively pursued would yield early results.

Generally the total requirements of specialist materials are not large enough to attract the existing industry to produce, economically, the materials required for the specialist trade such as the aviation industry. This we can get over if the production of raw material is restricted to a small number of specifications and is classified for use by trades. Initially instead of the industry to go through the laborious process of analysis etc. and other methods for examination of suitability etc., work done in USA by the Society of Automotive Engineering in this connection particularly steels will be of some assistance in this rationalisation.

Assistance by Government for laboratory and process control at the existing establishment will give confidence to the specialist equipment manufacturers to use indigenous raw materials; likewise establishment of 'metrology' laboratory at the several industrial estates would give confidence on indentors for 'essential components'. While the departments concerned have agreed to for placing/placed at many industrial estates general purpose machine tools for quality production and a centralised tool fabrication shop, general laboratory and inspection facilities, consideration for centralised unit for maintenance of these machines and also such equipment which can produce economically 'one off' components required for the maintenance of machines or for a specialist industry has not been there so far.

A paper from Messrs Bharat Heavy Electricals suggests:

(i) Indian steel plants should be persuaded to take up production of variety of weldable quality carbon steels, low alloy steels and special steels required for boilers.

(ii) Development of high temperature resistant special steels and facilities and researches on high temperature properties of such steels for boiler tubes and plates for pressure vessels, tanks, etc.

(iii) For manufacture of boilers of 110, 200 and 300 mW. mild and seamless, low and high alloy steel tubes will be required, a plant may have to be set up for the purpose.

Production of Metals

Production of electrolytic magnesium metal, sodium, misch-metal, lead and antimony from secondary battery sources and various metal powders and method of detinning etc. have been described in papers from Central Electro-Chemical Research Institute, Karaikudi, who have developed processes for these metals.

Know-how has been developed in the Atomic Energy Establishment Trombay on the production of high purity zirconium compounds and zirconium metal from Indian zircon. Nuclear grade zirconium sponge is being produced on pilot scale. Kilogram quantities of zirconium oxide have been made available for defence applications, and micron grade zirconium powder to local manufacturers of photoflash bulbs.

Based on pilot plant experience, a proposal has been finalised on the setting up of a zirconium plant capable of producing 50 tonnes of diverse fabricated shapes per year. While the emphasis in this plant will be to meet the requirements of the nuclear power programme, the plant will have adequate expansion capacity to accommodate additional demands.

In a developing country like ours, the need for self-sufficiency in refractory metals which play a significant role in the fields of nuclear engineering, electronics, defence and aircraft industries, has been fully realised. In view of this, a number of investigations on the extraction and purification of the metals like W, Ta, Mo, Nb, V, Ti and Zr have been initiated in the Trombay establishment. It has been possible to obtain pure and ductile niobium and tantalum by calcio-thermic reduction of their oxides followed by arc and electron beam melting. Massive zirconium metal has also been prepared by the same process. Low temperature alumino-thermic reduction of the oxides of Nb, Ta, V, W and Mo, in presence of a suitable eutectic has been met with success. In all cases, the metal has been obtained in massive form, well separated from the slag with good yield. Tungsten and molybdenum metals thus obtained, can be purified easily by arc melting. Preparation of tantalum powder by various processes is also in progress to assess its suitability as 'slug' for electrolytic capacitors.

Tantalum powder is produced from indigenous sources by the metallothermic reduction of oxides and double fluorides. The powder so produced is compacted into pellets of controlled porosity with embedded tantalum lead wire using a special die. The pellets are then sintered at about 2000° under a vacuum of 10^{-4} mm. Hg, to increase their mechanical strength. The sintered pellets are then anodised in a phosphoric acid bath to form the tantalum oxide dielectric on the surface. The tantalum anode is then tested to study the electrical characteristics, chiefly the d-c leakage current. The work is in a development stage. Preliminary results have shown that some of tested pellets are satisfactory for use as capacitors.

Gallium metal is finding increasing use in the industry mainly because of the semiconductor characteristics of its intermetallic compounds with elements of V group.

Due to the high price of gallium and its use as a semiconductor it is suggested that during the extraction of aluminium from bauxite, research may be conducted to find out a suitable method to extract gallium and vanadium as by-products.

Messrs A.P.V. Engineering Co. Ltd, in their paper observe that indigenous requirements of non-constructional metal barring probably grey cast iron, are fully met locally. Substitution for imported metals can therefore only be relative in nature. The only three really indigenous materials available are cast iron, carbon steel and aluminium. Any possible reduction in import has to be through increased use of these materials by way of partial or total replacement. Here again having regard to the special requirements of chemical process equipment, in particular, from the standpoint of corrosion resistance and process/product contamination, there are limitations. However to cite a few examples the following might be considered:

At present molasses based alcohol plants employ mainly copper as material of construction for the columns, condensers and piping in the distillation section. Particularly when the end use of alcohol is for industrial purposes, copper could be substituted by steel construction except probably in the case of the wash or analysing column which handles acidic fermented wash.

Corrosion resistant steel linings are worth considering where it is wished to retain the corrosion resisting advantages of solid corrosion resistant steel of other special metals. The lining can either take the form of close fitting sheet material or integrally bonded claddings. The latter is again ruled out as import will be necessitated. Sprayed on coatings because of the porosity of the deposited metal is not always satisfactory. When heat transfer through the metal wall is involved, sheet lining could adversely affect heat transfer efficiency but a compromise is necessary somewhere. As the backing material will be steel, any lining material should be capable of being welded to steel. Overseas literature indicates that in the case of stainless steel, for construction requiring a wall thickness of 6 mm. or under it is usually more economical to make use of solid material and the lining becomes definitely economical above 16 mm. wall thickness.

In shell and tube exchangers of stainless steel and other special metals construction, where the tube side governs corrosion resistance, steel tube plates with sheet lining on the header side can assist in saving imported thick alloy tube plate material.

Substitution

The chemical industry uses bulk of imported metals and specific structurally strong materials of construction which are simultaneously corrosion resistant to the specific conditions. Major usage is that of various stainless steels; copper and its alloys, nickel and its alloys, the rest being made up of tin, lead, zinc, the rare metals and their alloys.

The possibilities offered by aluminium and its alloys in the field of corrosion resistance materials of construction, are discussed by Dr Altekar in his paper. The types of alloys that can be used for handling and processing of chemicals, for nuclear technology, petroleum industry, in cryogenics etc. have been mentioned.

The Research Department of Eyre Smelting has experimented with two of the more promising Al base bearing alloys, the first an aluminium base complex alloy and the other an aluminium-zinc-copper ternary alloy. Both the alloys offer interesting possibilities as bushings and bearings in place of tin bronzes.

In automobile radiators in case of an emergency, substitution to steel fins can be resorted to in place of copper fins as suggested by Messrs India Radiators Ltd, Madras. However, it is to be noted that in the long run such a step will only result in wastage of valuable materials due to the limited life of the radiator. The use of thinner material may be positive step to conserve copper, but the success of such a move will need the active co-operation of the vehicle owner. Lastly, among the various metals available for substitution, aluminium appears to be a logical choice. This is due to the high thermal conductivity and lightness of the metal, which are important considerations in the construction of radiators. Thus, if the world price of copper continues to remain at the present levels, large scale substitution of copper by aluminium will become an economic necessity in the radiator industry.

Polishing, coating, soldering, enamel finishing, anodizing techniques have been developed at CECRI which render aluminium metal suitable for various end uses.

Substitutes in case of nonavailability of tin sheets, tin and lead, copper sheets, solid drawn copper tubes etc. needed in sandalwood industry in Mysore have to be developed. Shri D. D. Desai has suggested a thorough investigation to substitute copper by aluminium.

Corrosion Advisory Bureau has been working under the Metals Committee of CSIR and various sub-committees have been formed to undertake research and study on various aspects of corrosion and protection of metals and alloys in different media. A 'Corrosion Map of India' is also under compilation with data from various exposure stations distributed all over the country. In addition the Bureau runs and advisory service for industrial problems.

Various researches carried out on corrosion prevention of various metals and alloys have been reported in papers from CECRI and certain paints and inhibitors etc. have been developed and studied.

Extensive research has been carried out towards the practical aspects of manufacturing bi-metals from indigenous sources with quite successful results by Messrs Sovereign Rolled Gold Manufacturers, Bombay.

Copper/brass-gold, iron-brass/copper, copper-silver etc. bi-metals are already on commercial scale production. They are working on the development of different bi-metals which can replace the imported raw material or use cheaper raw material; alùminium-silver, iron-aluminium etc. are some of the examples of it. It is hoped that further development of this industry will help our nation to be self-sufficient in the parts manufactured from such metals.

The new developments in the rapidly expanding electronics industry call for more and more components and assemblies such as crystal holders, capacitors, meters, cathode-ray tubes, many types of vacuum tube, resistors, thermo-electric coolers, semi-conductor devices, etc. that require hermatic glass-to-metal or ceramic-to-metal seals. The metals and alloys used for this application should essentially have low thermal expansion. Some of these alloys, e.g. Invar and Kovar are being imported at present for the electronics industry. Making these alloys indigenously and fabricating them to thin strips, sheets and wire suitable for glass-to-metal seals have been reported by the Atomic Energy Establishment. The test results conducted on the components, so far, and comparison with those made from the imported material are presented.

The Metals Research Committee, one of the research committees of the Council of Scientific & Industrial Research, has been active in sponsoring research on metallurgical subjects at the Universities, Industrial Laboratories, etc. The membership of the Committee comprises metallurgists and others drawn from Industries, National Laboratories, Universities, Defence Department, Atomic Energy Establishment and other Government Departments.

During the last war, the Metals Committee had sponsored a number of research schemes which were directly of assistance to the war effort. These included the manufacture of steel for surgical instruments, high silicon steel sheets and a number of alloy and tool steels required for industrial production and ordnance etc.

The Metals Committee has also sponsored investigations of general national importance such as the study of manufacture of iron in the Adibasi Furnaces and the causes of corrosion resistance of ancient iron products including the Iron Pillar of Delhi. A documentary film which is of considerable historical importance, based on this investigation, has also been made by the Ministry of Information & Broadcasting.

The Metals Committee also sponsored the Study of the Demand for Steel in India during the Second Plan period.

The Metals Committee in the last three/four years has set up the Corrosion Advisory Bureau to create an awareness in the industrialists to the serious economic loss caused by corrosion.

The resources of technical equipment, research facilities and technical manpower at the National Metallurgical Laboratory are always available to the various Government and private agencies and for most to the Defence authorities and we assure all concerned that given the requirements and raw materials, the National Metallurgical Laboratory will not be found wanting in relentless effort to meet the demands within our limitations of equipment and manpower. The defence requirements of various strategic materials have been met by us from time to time and we shall do so in future giving the top priority necessary during the present emergency.

8. Paper, Pulp, Forestry, Textiles, Man-made Fibres, Wool, Leather, Plywood

COTTON

Cotton Shortage

The group expressed great concern over the shortage of cotton of all staple lengths and recommended vigorous measures for increasing on the one hand, the yield per acre through more scientific farming and on the other development of longer staple cottons.

It was generally agreed that man-made and synthetic fibres should play an increasing role in the industry both as a means of alleviating the shortage of raw material and also for producing newer and better type of blend fabrics to cater to export markets. Viscose staple fibre can be used in blends with cotton only to a limited extent (about 15 per cent blend) and even this blending can produce appreciable reduction in fabric quality and wear life in the finer counts (finer than 30s). The use of viscose staple in blends in the coarse and medium counts can increase only if the economics of such blending are made favourable by bringing down the price of the viscose staple. Polynosic fibres have a much better promise not only to replace cotton in substantial quantities in blends but also to be used by themselves in place of cotton. Intensive research should be carried out in developing a suitable pulp for polynosics from indigenous sources and for spinning the fibre from the pulp. The group was informed that such work is already under progress at Gwalior Rayons.

The group recommended the setting up of factories for the manufacture of synthetics such as polyesters, polyamides, acrylics, and PVA fibres utilising the by-product resources of the petrochemical complexes being set up. Many members stressed the need for long term research and development work in the field of fibre engineering. It was suggested that the utility of the hydrophilin PVA fibres be especially investigated in suitable blends with cotton. Ternary blends of cotton/viscose and synthetics were also recommended for study. The possibility of using Ramie fibres in suitable blends with synthetics should also be investigated.

Dyestuffs

It was suggested that possibilities of developing and manufacturing the dyestuffs now being imported be investigated in view of the fact that most of the intermediates would be available in the country from the Hindustan Organic Chemicals Ltd.

Machinery Development

The greatest stress was laid on the necessity for setting up suitable facilities for design and development of textile machinery and of ensuring effective collaboration between the various research institutes and the machinery manufacturing industry so that we could eventually produce the most modern type of machinery without imported know-how. It was necessary in this context to develop and manufacture related process control and quality control equipment also. Without the former, modern machines are not complete. It was suggested that at the existing research institutes much more effort ought to be directed towards these areas than at present. One member suggested the possible use of PVC linings in place of the stainless steel at present used in some of the chemical processing machinery.

Product Development and Market Research

Some members of the group underlined the need for a properly directed market research particularly with a view to assess the needs of importing countries in terms of newer and better products such as different types of blends, foam backed fabrics, wash and wear fabrics, stretch garments etc. so that developmental work could be undertaken in these fields. There is particular scope for application of methods of fabric engineering in these areas.

JUTE

The needs of the industry in terms of research and development are as follows :

Shortage of Fibres

The requirement of jute in 1970-71 will be of the order of 9.8 million bales. The production at present is 7.5 million bales. Thus there is need to increase the production by about 30 per cent in the next five years through better farming techniques as well as through development of better strains of jute.

Product Development

Jute, as a packaging material, is meeting with increasing competition. There is an urgent necessity therefore to improve the quality and reduce the weight of jute packages. For example loss of cement and other materials in transit in jute packages must be eliminated by the development of a better product. Some success has already been achieved in developing a lighter and better jute package for wool for the Australian market which overcomes largely the contamination of wool with jute fibres. Lamination and other techniques should be fully investigated in this connection.

New uses for jute and hessian fabrics must also be constantly investigated. Carpet backings of jute have already been successfully developed. Development for outlet of jute in the tapestry and furnishing trades should be pursued. There was also mention of possible uses of jute fabrics for road and canal linings, the latter to prevent seepage. The setting up of the pilot plant at IJMARI for product development is a step in the right direction.

Batching Oil

Different importing countries have different acceptable specifications for the batching oil used during jute processing with the result that different types of oil have to be used for products meant for exports to different countries. There is a great need to develop, in collaboration with the IIP, a cheap and suitable batching oil acceptable to all countries.

Modification of Jute Fibres

Intensive research needs to be carried out to assess the feasibility of modifying the jute fibre to make it more suitable for a wider range of use and in blends with other fibres. The possible uses of 'wollenized jute' should be fully investigated.

WOOL

Shortage of Wool

The greatest need of the industry is good quality indigenous wool. The necessity for developing suitable breed of sheep and of controlling their diet and of trading and marketing wool in a scientific manner was stressed.

Many members emphasised the necessity of investigating intensively the possibility of replacing wool partly by synthetics such as acrylics, polyamides and also by viscose staple fibre in binary and ternary blends. The specifications of the defence department ought to be changed suitably so that such blend fabrics are acceptable. The group was informed that many modifications had already been done by the defence department.

There appears to be a particular scope for polyurethane foam backed fabrics to replace woollens and development work in this direction including the manufacture of suitable adhesives must be intensified.

Study of Wool Fibres

Some members emphasised the need to undertake long term research on the study of the Indian wool, in particular, its setting and felting characteristics, with a view to improve its utility.

Teaching Institute for Wool Technology

The members unanimously expressed the need for providing a good degree and post-graduate course in wool technology at one or more of the existing universities.

PAPER AND PULP

Pulp for Paper and Rayons

It was generally agreed that bamboo should be exclusively or at least substantially used for making paper grade pulp while bagasse, eucalyptus and tropical pines should be mainly used for rayon grade pulp although bagasse and even jute sticks can and are used for making paper. Some doubts were expressed as to whether bagasse would be available in enough quantity as it was being used as fuel in sugar mills. Similarly, it was pointed out that other possible raw materials, e.g. jute sticks, reeds etc. were not always easily available because of the lack of organised facilities which should be set up. Many members expressed the acute necessity of a forward looking forestry and plantation programme to ensure a rising and continuous supply of bamboos, eucalyptus and hard woods for the pulp industry.

It has been pointed out that semi-chemical pulping methods should be used more and more as they give a greater yield of pulp. It was pointed out that while with bamboo the yield by the semi-chemical process is not as high as with the types of soft wood used in Europe it was much higher than with the wholly chemical method. There was however the question of machines which were not designed to handle all types of raw material. It was suggested that big central pulp factories be set up, each equipped with latest tyed of machinery to handle particular raw materials. These factories could then supply pulp to the paper factories.

Machinery

While there are a few units which manufacture machinery for the paper industry, there are certain units, e.g. digesters and filters which are still imported. Just as in textiles there is need to develop the machinery manufacturing industry. Since the demand for any particular machine is not high it is necessary to investigate the possibility of setting up units manufacturing similar machinery for different allied industries.

Need for a Research Association

Some members recommended the setting up of a paper and pulp cooperative research organisation to cater to the needs of the industry.

Facilities of Teaching Paper Technology

Members felt that degree and post-graduate courses in paper technology should be set up at one or more universities.

LEATHER

Raw Material

The quality and quantity of hides and skins has to be improved through modernisation of slaughter houses, better preservation and quality control of hides, improvement of livestock and rationalisation of marketing procedures.

Tanning Material

Some substitutes of wattle bark have been found out, e.g. from Babool but these are in short supply and the over-riding need is to ensure a continuous supply of such substitutes through a systematic plantation schedule. The use of sulphite waste liquor from the paper mills (using the sulphite process) as a tanning material was suggested.

Auxiliaries and Tanning Machinery

Most of the auxiliaries for the manufacture of good quality finished leather are not manufactured in the country because of their limited quantities required. If these or related auxiliaries can be used in other allied industries then only their manufacture can be economically taken up by one or two firms.

Similarly, the demand for tanning machinery was limited and only a concern manufacturing other but similar types of machinery can profitably undertake the development and manufacture of such machines.

By-product Utilisation

There is a great need to reduce effective cost by utilisation of by-products from slaughter houses. It is necessary for this purpose to have modern slaughter houses.

Training of Technicians

As in wool and paper there is a need to offer diploma, graduate and post-graduate course in leather technology in one or more universities.

9. Mining, Ores, Minerals, Geophysics, Oceanography

Introduction

Strategic value of minerals. Minerals, metals and alloys play an extremely important role in defence and in industrial development of a country.

The Government of India has given a very high priority to the study of the country's environmental and natural resources.

Need to be self-sufficient. The recent emergency in the country has made it imperative to exploit the available mineral resources and to develop the necessary technical know-how to extract usable metals, produce important alloys and develop suitable substitutes with indigenous raw materials so that dependence on foreign supplies for such essential materials is reduced and eliminated wherever possible.

Working Group 9. The Working Group 9 of the conference on Research and Industry held on December 20 and 21, 1965 was set up to look into the problems of ores and minerals, mining, geophysics, and oceanography. A key paper for discussions at the conference was prepared by a Working Group Committee, which was amended and finalised after detailed discussions during the conference in Delhi. The finalised version of the key paper is presented here.

The purpose of this key paper is to focus attention on some of the major problems of ores and minerals, mining, geophysics and oceanography. Many of these problems are fairly well known and their solutions have also been suggested from time to time. However, necessary steps to implement these solutions have not been taken in many cases.

Need for action. The immediate necessity is that of deciding overall priorities, taking decisions and their implementation in shortest possible time. Delays and indecision can be avoided by reduction of 'non-productive' staff and by vesting authority in the persons who are responsible for the execution of work.

ORES AND MINERALS

General Remarks

Unfavourable trade balance. There is an imbalance of trade in metals, alloys, ores and minerals roughly of the order of Rs 100 crores in foreign exchange. In 1964, India exported ores and minerals amounting to Rs 77.5 crores and imported the same worth Rs 16.5 crores. in the case of metals and alloys, India's imports came to Rs 161.8 crores and the exports amounted to Rs 17.0 crores.

Main items of export and import. India's main items of export are iron, manganese, mica, precious and semi-precious stones. India's main imports are iron and steel materials, pig and sponge iron, various ferro-alloys, copper, zinc, tin, aluminium, sulphur, lead, apatite (rock phosphates), asbestos, nickel, brass, bronze and various other non-ferrous metals and minerals.

Deficient production. Empirical analysis indicates that in 1964, the country required to produce minerals and ores amounting to nearly double the figure of Rs 55 crores which it actually produced, to promote export of minerals and ores, eliminate import of metals and alloys, promote exports of metals and alloys and meet the growing indigenous requirements.

Mineral provinces. The mineral provinces broadly consisting of Dharwar region, Cuddapah basin including the Eastern Ghats, Satpura region including Singhbhum and Hazaribagh, Aravalli region including the mineralised areas of Gujarat, Himalayas including Jammu & Kashmir and Assam have been reported to contain a number of economic mineral deposits. Many occurrences of various other minerals have also been reported in these regions.

A brief examination of the mineral provinces of India indicates that by and large, the country is reasonably well placed in respect of many minerals.

Geophysical investigations. Geophysical prospecting activities so far have been confined only to the areas of known occurrences of mineral resources, and about 110 investigations have been made throughout the country. Large efforts are necessary to survey the known occurrences and also explore other areas for mineral potentialities.

Exploration research. Geophysics is an established tool for mineral exploration and it has been applied with great advantage in other countries. World statistics indicate that the geophysical efforts have been considerably limited in the entire region of Asia and the proportionate amount of money spent on mining geophysical research is practically negligible. For a sound mineral exploration programme in India, it is essential that geophysical techniques are systematically and extensively applied and research for mineral exploration is taken up simultaneously for geophysical instrumentation, development of methods and techniques and ore genesis under Indian geological environments.

Status of Some of the Important Minerals

The following analysis brings out some of the outstanding problems. An attempt has been made to suggest some broad remedies. The ores and minerals have been arranged according to their import valuation.

Copper

Import and requirements. India imported copper worth Rs 24 crores in 1964. During the Fourth Plan period, it is estimated that the country would need about 230,000 tons of copper costing about Rs 368 crores.

Production capacity. The capacity of copper production envisaged during the Third Plan was 22,000 tons and that actually achieved is only

Table 1—Reserves of Copper Ore

Block/Mine/Area	Proved (tons)	Grade (per cent copper)	Probable (tons)	Grade (per cent copper)	Estimated (tons)	Grade (per cent copper)
RAJASTHAN						
Khetri (Madhan Kudhan section)	36,270,000	1	—	—	—	—
Dariba Mine Block	207,000	2.55	—	—	—	—
Dariba Nala Block	—	—	203,000	2.5	—	—
BIHAR						
Rakha Mines (Roamsideshwar Block)	—	—	—	—	14,000,000	1.24
AREA UNDER I.C.C. LTD						
Mosabani Mines	3,568,320	2.44†	—	—	—	—
Surda Mine	283,338	2.30†	—	—	—	—
Pathargora Mine	70,618	1.71†	—	—	—	—
Kendadih Mine	5,411	2.74†	—	—	—	—
MAHARASHTRA						
Thaneswasna, Chanda Dist.	13,600,000*	0.5	—	—	—	—
MADRAS						
Mamandur Area, South Arcot District	—	—	—	—	800,000	0.65

*Source : Government of Maharashtra

†Reduced value

Table from I.B.M. Yearbook, 1962, p. 262

10,000 tons. The planned capacity for the Fourth Plan period is 37,000 tons. The investment for new plants during the Fourth Plan period both in public and private sectors is expected to be of the order of Rs 140 crores including a foreign exchange component of Rs 65 crores.

Reserves. Reserves of copper under the different categories are given in Table 1.

Exploitation of known reserves. Indian Copper Corporation has about 4 million tons of proved copper reserves of 1.7-2.7 per cent grade. Presently they are engaged in a project to replace its old smelter of 7,200 tons per annum capacity by a new flash smelter of 16,500 tons capacity and increasing its mining production. The Corporation envisages the raising of ore, enough to produce only 12,700 tons per annum. The Corporation's leaseholds are reportedly rich and *prima facie* it appears feasible to realise the full smelting capacity of 16,500 tons. The possibility of realising the full production at the earliest date should be examined.

Simultaneous efforts should continue to exploit Khetri, Kolihan, Dariba and Rakha reserves in the country.

It is ascertained that recent exploration and drilling have shown promising indication of copper at Ingaldhal and Kaliadi in Mysore State and at Agnigundala and Mailaram in Andhra Pradesh. In these areas surveys and exploitation should be carried out.

Exploration for new reserves. Possibilities of search for new deposits in more favourable areas like Khetri Belt, Southern Mysore, South Arcot district of Madras, and in parts of Cuddapah basin should be intensified to meet the future demands. Geological surveys be undertaken to see if porphyry type of copper deposits are found in the Himalayan region.

Production from low grade ores. In Chanda district of Maharashtra, 13.6 million tons of proved reserves of grade 0.5 per cent of copper have been reported by the Maharashtra Government and efforts should be made to investigate these reported occurrences.

Need for new smelting plants. Efforts should be made to see if installation of new plants can be undertaken with indigenous technical know-how and expertise to minimise the foreign exchange component.

Wherever reserves have been proved exploitation should begin at the earliest.

Conservation. The use of copper for non-essential purposes such as manufacture of cooking utensils and household goods should stop.

Collection of copper scrap should be taken up with some price stimulation, if necessary.

Zinc and Lead

Requirements of zinc. The current requirements of zinc is estimated at 108,600 tons and it is likely to increase to about 190,500 tons by the end of the Third Plan period and to 225,000 tons by 1970-71. In 1964, India produced 10,744 tons of zinc and imported 67,180 tons from abroad costing about Rs 10 crores.

Reserves. The ore reserves at Mochia Magra in Zawar are estimated to be 8.13 million tons of proved reserves and 10.16 million tons of probable reserves, of nearly 7 per cent metal content of both lead and zinc. Balaria hills in the same region contain proved and probable reserves of 10.16 million tons of ore.

Exploitation of known reserves. Immediate mining of the known reserves in Rajasthan and intensive search in Cuddapah basin and other areas of known occurrence should be taken up to meet the requirements of the projected smelters which are presently based on imported zinc.

Projected zinc smelters. Presently, there is no zinc smelter in the country. The only deposit of economic importance so far known (at Zawar in Rajasthan) is being mined by the Metal Corporation of India, who prepare zinc concentrates and get them smelted in Japan on a toll basis. The Metal Corporation is also engaged in installing an 18,000 tons per annum smelter at Debari. The required zinc ore for this smelter is to be obtained from the Zawar deposit. It has been reported that the Zawar deposits may actually be capable of sustaining metal production of the order of 50,000 tons per annum. Thus the efforts should be made to ensure this target from the Debari smelter.

A scheme with Polish assistance to establish a zinc smelter of 30,000 tons capacity based on imported concentrates is under consideration.

A zinc smelter of 12,000 tons per annum capacity based on imported concentrates is being set up at Alwaye in Kerala in the private sector with Canadian collaboration.

Need for new zinc smelters. In view of the critical importance of zinc and the fact that zinc concentrates can be obtained in the international market, there is a case for establishing two more zinc smelters of about 50,000 tons capacity each, based on imported concentrates.

Research for substitute for galvanising. Since the country has adequate reserves of aluminium ore, aluminising of large structures in place of galvanising should be investigated. Such a project has already been taken up by NML and CMERI as a joint programme.

Requirements of lead. The current requirements of lead are about 55,000 tons and it is expected to increase to about 146,000 tons during the Fourth Plan period. The indigenous production in 1964 amounted to just over 6,000 tons and the country imported over 34,000 tons at a cost of Rs 4 crores.

Need for lead smelters. It should be possible to meet the short term requirements of lead within the country provided the required capacity of installation of lead smelters is established.

Exploration for new reserves. Areas where occurrences of lead and zinc have been reported should be explored intensively to establish the reserves to meet the long term requirements. In the Zawar area the leaseholds have not been adequately explored by the lessees. It is therefore necessary to explore the Zawar area more thoroughly in order to establish additional reserves in this region, and to find out whether an additional smelting capacity can be justified.

Tin

Import and requirements. There are no economically workable deposits of tin in India though occurrences have been reported in Bihar, Rajasthan, Gujarat and other places. India imported just over 5,000 tons of tin at a cost of Rs 7.6 crores during 1964. The import of this metal during the Fourth Plan period is estimated to be over 50,000 tons costing about Rs 76.5 crores.

Need for exploration. The known occurrences of tin deposits should be investigated and exploration efforts for tin intensified to see if some reserves can be established within the country.

Aluminium

Production, import and requirements. India produced 590,000 tons of bauxite in 1964 and 55,000 tons of metal aluminium. A total of 22,700 tons of aluminium was imported amounting to Rs 6.8 crores during the same year. The demand for aluminium metal during 1970/71 is estimated to be 235,000/240,000 tons. Thus even after taking into account the indigenous production of the metal, the country may need to import aluminium metal to a cost of Rs 80 crores during the Fourth Plan period.

Reserves. The total estimated reserves of bauxite in different states of India amount to about 250 million tons. With abundant bauxite deposits there is no reason why aluminium has to be imported. Extra production capacity should be provided to meet the growing demands.

To meet these demands it may be necessary to choose a suitable area for detailed proving for a particular smelter with reference to its location.

Drawbacks in aluminium production. The main drawback in increasing aluminium metal production so far has been the lack of cheap electric power and nonavailability of cryolite.

It is felt that by proper planning the country cannot only achieve self-sufficiency but can also have an exportable surplus in this vital metal.

Utilisation of low grade bauxite. Studies to utilise low grade high silica bauxite and production of aluminium should be encouraged. Such projects could be taken up by NML and Indian Institute of Science, Bangalore.

The feasibility and industrial application of bauxite upgrading processes be examined by NML and NCL.

Research for using as substitute metal. The Central Electrochemical Research Institute has taken up investigations on utilisation of aluminium as a substitute for copper and zinc with a view to reduce substantially the drain on foreign exchange. Efforts in this direction should be intensified to find more uses of aluminium as substitute metal for copper and zinc.

Nickel

Import and requirements. Presently there is no indigenous production of nickel and the country's entire requirements are met by imports. In 1964, 2,470 tons of nickel was imported at a cost of Rs 1.9 crores. This requirement is likely to increase to 15,000 tons during 1970-71. The total foreign exchange requirement during the Fourth Plan period is estimated to be over Rs 25 crores.

Laterites as source of nickel. The Geological Survey of India have reported enrichment of nickel up to as much as 1.5 per cent in laterites of Manipur, Andaman, and Orissa. Most of the enriched nickel occurs in the magnetic iron oxide minerals in laterite and nickel is believed to be present as oxide or hydrated oxide.

Geophysical exploration for enriched nickel. Magnetic methods of geophysics may be useful in locating enriched zones.

Extraction of nickel from laterites. Immediate investigations are needed to explore the possibilities of economic extraction of nickel from such sources. NML should intensify these investigations.

Need for exploration. Nickel is one of the strategic minerals and exploration efforts should be intensified in areas where occurrences of nickel have been reported.

Recovery as by-product. Metallurgical studies are necessary to find methods of economic production of nickel as a by-product of copper production from Singhbhum, Bihar. Recent exploration in Singhbhum holds promise of extracting nickel from uranium ore. Exploitation and utilisation of these nickel sources should be speeded up. AEC, NCL and NML could look into these problems.

Vanadium

Import. All the requirements of vanadium for the steel industry are met through imports.

Reserves. Vanadium-bearing titaniferrous magnetites occur in Bihar and Orissa. The reserves of these deposits are estimated to be at 22.32 million tons containing 0.5 to 3 per cent V_2O_5.

Research for extraction. NML carried out some research on hydro-metallurgical treatment of vanadium bearing magnetites for the production of V_2O_5. Pilot plant tests and study of the economics of the extraction of vanadium be taken up by the NML on a priority basis.

Chromite

Production and export. India is a substantial producer of chromite. During 1964, over 33,000 tons of high metallurgical grade chromite was produced valued at Rs 0.2 crores and 31,000 tons of chromite was exported valued at Rs 0.38 crores.

Reserves. The total proved and probable reserves of chromite in India are placed at about 5 million tons. Detailed investigations in Bihar, Mysore and Orissa are likely to indicate more reserves.

Need for exploration. Exploration efforts should be continued in other areas where occurrences have been reported to establish reserves for future requirements.

Conservation. In view of the limited reserves of chromite of metallurgical grade, and due to shortage of nickel, export of high grade chromite should be banned. Efforts should be made to beneficiate low grade ores. Technology and economics of utilising lumpy chrome ores (containing low silica and FeO about 20 per cent) should be worked out by NML.

Magnesite

Production and export. During 1964, India produced about 2,08,000 tons of magnesite ore valued at Rs 0.4 crores and exported about 36,000 tons amounting to Rs 0.73 crores.

Reserves. India is one of the important producers of magnesite in the world. Reserves of good quality ore estimated at 119 million tons are found in Madras, Mysore and Uttar Pradesh.

Need for metal production plant. No plant for production of magnesium metal exists in the country. Immediate steps should be taken to set up the magnesium plant not only for meeting indigenous requirements but also for export promotion. The National Metallurgical Laboratory have undertaken a detailed project to set up a pilot plant for recovery of magnesium and it should be given top priority.

Recovery from sea water. The possibilities of recovering magnesium from sea water and bitterns should be investigated by CSMCRI, Bhavnagar.

Titanium

India is a very important producer of ilmenite but the internal consumption is hardly 5 per cent of the total output and bulk of the quantity produced is exported.

Reserves. Titanium in the form of rutile and ilmenite is available in Madras, Kerala, Maharashtra, Andhra Pradesh and Orissa.

The reserves are estimated to be at 356 million tons of ilmenite in Madras and Kerala, 0.24 million tons of ilmenite in Maharashtra, 70 million tons of titaniferous magnetite in Bihar, Orissa and Mysore.

Need for export promotion. Export of ilmenite has been falling considerably partly due to the competing sources that have developed. To utilise the large reserves of this important mineral we should embark upon finding favourable markets for export and also set up alloy plants etc. for indigenous uses.

Gold

Gold is an essential metal not as much for industrial purposes as it is to maintain solvency of the country.

The reserves of gold at Kolar fields are going down. All the available know-how and expertise available at Kolar should be utilised in other areas promising of gold. Operations Research studies should be undertaken in the Kolar Gold Fields to look into the future potentialities of this region.

Immediate steps should be taken to stimulate gold production in areas such as Anantapur in Andhra Pradesh where recent exploration have revealed good concentration of the metal.

Rare Metals

Recovery as by-product. Some of the rare metals like molybdenum, tantalum, columbium, neobium, vanadium, tungsten, antimony, etc. are found in minor amounts associated with other ferrous and nonferrous ores. With proper care during smelting for major metals the former could be obtained in appreciable amounts as by-products and could be used in making ferro and other alloys indigenously.

Potential sources. Another source of these rare metals is the pegmatites which should be prospected intensively. Systematic examination of mine dumps, particularly those of base metals and pegmatite deposits may lead to the recovery of antimony, tungsten and other rare metals.

Ferroalloys

We are importing sizeable quantities of ferroalloys roughly estimated at rupees one crore annually, and the demands are likely to increase substantially during the Fourth Five-Year Plan.

Most of the raw materials for ferroalloys are available within the country. Plants for their production can be set up at suitable places, if special indigenous electric furnaces are made available.

Heavy Electricals, Bhopal, NML and Indian Institute of Science, Bangalore may study these problems.

Sulphur

Import and requirements. India imports about 0.24 million tons of sulphur annually at a cost of Rs 4.5 crores. It is likely that the import of sulphur during the Fourth Plan period may be of the order of Rs 95 crores.

Reserves. So far, sulphur is not being produced within the country. Reserves of pyrites/pyrrhotites in the country are estimated as follows:

Amjhor in Bihar	391 million tons of sulphur averaging 40 per cent
North Arcot in Madras	0.017 million tons of pyrrhotite containing 14 to 25 per cent sulphur
Chitaldrug in Mysore	2.030 million tons of pyrite containing 15 to 30 per cent of sulphur

Need for production. The known reserves of pyrites in the country could meet the present requirements provided immediate steps are taken to exploit these deposits. Urgent measures should be taken to utilise these deposits on a top priority basis.

Production of elemental sulphur. No occurrence of sulphur ore is reported in the country. To meet the requirements of elemental sulphur the following steps are worth considering:

It is gathered that the OUTOKOMPUOY process of Finland may be found suitable for manufacture of elemental sulphur from pyrites which is found in adequate quantities in the country. Intensive research should be initiated to develop this process, or modification of the process if necessary to manufacture elemental sulphur.

Recovery of sulphur from the coke oven batteries already established and to be established in future should be given priority. The processes available are well established in industry elsewhere and implementation of such schemes is called for. In this connection, the high sulphur coals of Assam (3-8 per cent) attain particular significance.

Some laboratory work has been carried out for the recovery of sulphur from sea water bitterns containing $MgSO_4$. These investigations should be intensified and carried out on a high priority basis.

Apatite (Phosphates)

Production, import and requirements. In 1964, India produced 4,050 tons of apatite valued at about Rs 159,000 and imported about 0.5 million tons amounting to Rs 3.9 crores. The import envisaged during the Fourth Plan period is of the order of Rs 58 crores.

Reserves. The total reserves of apatite in Singhbhum and Visakhapatnam have been reported at 0.87 million tons containing 30 per cent P_2O_5 and phosphatic nodules containing 20 to 27 per cent P_2O_5 of

Tiruchirapally at 8 million tons. These deposits should be investigated on a priority basis to meet the present requirements.

Potential sources. Phosphatic deposits including varieties of apatite in accessory form have been reported in Hazaribagh district in Bihar, Nellore and Srikakulam districts in Andhra Pradesh and some coal fields of Bengal, Bihar, and in certain areas of Bombay and Rajasthan in association with mica bearing pegmatites, manganese ore deposits, certain schists of Dungarpur in Rajasthan and some iron and manganese formations in Bihar.

A six-inch bed has been reported near Mussoorie in U.P. A guano type of deposit has been reported in Laccadive islands. Monazite, containing 26-28 per cent P_2O_5 occurs in Travancore beach sands. Phosphate is recovered from monazite in Alwaye factory as trisodium phosphate.

Exploration on continental shelves. It may be worthwhile to explore the possible occurrence of phosphate deposits on the continental shelves off our coasts. This work may be taken up by GSI and the National Institute of Oceanography.

Exploration to be intensified. Detailed exploration for apatite should be undertaken in areas of known occurrences and other regions to establish reserves to meet the long term requirements.

Asbestos

Production, import and requirements. The country produced about 3,000 tons of asbestos during 1964 and imported 36,000 tons costing about Rs 3.7 crores. The likely imports during the Fourth Plan period are estimated to be of the order of Rs 20 crores.

Reserves. The known reserves of chrysotile variety are reported to be 0.25 million tons in the Cuddapah region of Andhra Pradesh. Reserves of amphibole variety are reported to be 0.35 million tons in Bihar, about 25,500 tons in Mysore and over 26,000 tons in Rajasthan. These known reserves should be exploited on priority basis to meet the present demand.

Detailed exploration needed. The chrysotile variety of asbestos in Cuddapah basin is iron free and is reported to occur in association with basic sills. It is necessary to study the extent and depth of mineralisation and its association with sills in detail to explore for the reserves in this region.

Drilling and exploration of the occurrence of chrysotile near Gopalpura in Mysore district, Mysore should be taken up immediately.

Reported occurrences of asbestos in Madhya Pradesh, Madras and Orissa should be investigated in addition to those in Andhra Pradesh, Bihar, Mysore and Rajasthan to meet the future demands.

Pilot plant for chrysotile substitute. Efforts should be made for substitution of chrysotile variety by indigenous amphibole type to save foreign exchange. CBRI and NML have done some work in this direction. In the light of this work pilot plant studies should be undertaken.

Diamonds

The requirements of industrial diamonds is increasing considerably. Exploration and exploitation of the diamond bearing gravels should be undertaken.

The diamonds presently being mined should be sorted out and properly graded for industrial purposes.

The import of diamonds for the drill bit manufacture can be minimised by taking the following steps:

Bits should be sent for resetting at the proper time to obtain the maximum amount of salvage.

Chilled shots or tungsten carbide bits should be used wherever possible to economise on diamond bits.

Natural diamond should be substituted with artificial material, even if its efficiency and performance be slightly inferior to the natural diamond.

Fluorite

It is an essential mineral for steel as a flux, fluorine chemicals, production of synthetic cryolite, and refining of aluminium.

So far only two deposits at Ambadunga in Gujarat and Dungarpur in Rajasthan have been located. Mining operations at these deposits have just been started. The reserves, however, have not been fully established.

Exploration for further reserves in Madhya Pradesh and other areas should be undertaken.

By-product recovery from fluor-apatite in super-phosphate plants should be attempted.

Graphite

Graphitic schists containing 13 per cent graphite occur in Mysore and in Andhra Pradesh. Economic feasibility of beneficiating the graphite in these schists should be explored.

Ground Water

Need for ground water studies. Large tracts of the country fall under arid and semi-arid zones where ground water is the main source for domestic and agricultural needs. It is estimated that the yield from an irrigated land is nearly four times that of the yield from an unirrigated dry land. It should be recognised that water underground is more precious than precious metals and industrial minerals and it is essential to systematically explore for ground water more intensively than other minerals.

Collection of basic data. In order to enable give dependable advice on water supply schemes based on ground water resources, a great deal of basic work is necessary. A few items are listed below:

There should be a permanent agency collecting basic data, including the rock types encountered in the well and their character, depth of well, depth of water and rate of lowering of level at a given rate of pumping. An inventory of wells should be maintained and brought up-to-date. This data will enable to draw a water table contour map.

The study of fluctuation of water table in certain observation wells in each district must be carried out in order to make an assessment of the annual ground water recharge.

Porosity, permeability and specific yield characteristics of different types of rocks and their altered products have to be determined.

Studies relating to estimation of moisture content of soil samples at different depths and during different seasons of the year to evaluate the loss of ground water through evapo-transpiration.

Collection of information relating to run-off-characteristics of not only major rivers but minor streams also. A large number of stream gauging stations have to be established and records of run off maintained. This information extended over a period of years along with figures of rainfall will enable estimate of ground water enrichment each year.

Geophysical exploration. Systematic geophysical investigations, especially those based on earth resistivity to be carried out in order to find the depth of alteration and depth to bed rock. This information will help in better siting of bore holes and eliminating chances of failure.

Conservation. Since ground water is primarily dependent on rainfall, ways of preventing absorption of rain-water by adopting appropriate methods of cultivation, aforestation of the watershed zone, prevention of soil erosion through contour bedding, etc. have to be studied and adopted.

MINERALS AND PRODUCTS FOR EXPORT PROMOTION

Iron and Steel

Production, export and import. During the year 1964, India produced nearly 15 million tons of iron ore with pit head value of Rs 10.9 crores. About 10.5 million tons of iron ore including that from Goa was exported valued at Rs 37.2 crores. In the same year, India imported over 1 million tons of iron and steel materials costing Rs 100.9 crores, pig and sponge iron costing Rs 2.3 crores and ferroalloys costing Rs 0.6 crores.

Demand. Estimated demand of iron ore by 1970-71 is 33 million tons for steel industry and 25 million tons for export purposes.

Production of steel and ferroalloys. During 1964, India produced 4.34 million tons of finished steel, 1.32 million tons of pig iron, 150,000 tons of ferroalloys including 130,000 tons of ferro-manganese and 18,000 tons of ferro-silicon alloys.

Gap in production and demand. The production of steel at the end of the Fourth Plan period is expected to be 9.8 million tons. The gap between the demand and production during the Fourth Five-Year Plan is expected to be about 8 million tons estimated at Rs 440 crores. The import of alloy and special steel is expected to be of the order of another Rs 150 crores.

Reserves. India has over 21,000 million tons of iron ore reserves in the various parts of the country and these reserves can meet all the foreseable demands within the country and requirements for export promotion.

Export targets and production. Iron ore is the principal foreign exchange earner in the group of minerals and ores. The tentative targets fixed for export of iron ore by the end of Third and Fourth Plan periods have been given as 16.25 and 25 million tons respectively. With the large reserves available within the country, every effort should be made to achieve these export targets.

Bottlenecks in export promotion. Transport is the main bottleneck in adequate production and export of iron ore. Proper port and loading facilities are essential to enable heavier vessels to load the ores.

Our loading rate is 1,500 to 2,000 tons per day of 24 hours, against a loading rate of 3,000 to 4,000 tons per hour at some ports in other countries. It is hoped that these disadvantages will be offset after the developmental plans are completed.

Mechanisation of mines. Mining operations should be mechanised and every effort should be made to increase production and reduce the costs to capture new markets for export purposes.

Beneficiation. Presently the best grade iron ore situated 300-400 miles inland is being exported. Transport costs are exorbitant and the ore thus becomes less competitive in the world market. A number of low grade iron ore deposits occur close to the sea coast. With proper beneficiation and pelletising, this ore can fetch better price.

Necessity for pelletising. The technique of pelletising has to be developed on a priority basis. Within the country, it will solve the problem of iron ore fines which are presently unsuitable for the steel industry, and it will considerably help the export promotion.

Reorganisation of iron ore mining. There is no organised iron ore mining. Too many leases have been issued resulting in inefficient mining, low production and high cost. Mining efforts should be planned and concentrated in few selected areas to increase production.

Manganese

Production, import and export. During 1964, India produced about 1.3 million tons of manganese valued at Rs 6.5 crores, and imported about 7,800 tons of first grade manganese ore costing Rs 0.37 crores. The country exported about 1.6 million tons of ore amounting to Rs 13.8 crores. By 1970/71 the requirements for internal consumption are estimated to be 2 million tons, and 1.2 million tons for export.

Reserves. Workable deposits of manganese occur in Madhya Pradesh, Maharashtra, Mysore, Bihar, Orissa, Gujarat and Andhra Pradesh and the total reserves of all grades of manganese ore are estimated at 180 million tons. Out of these, about 49 million tons are of high grade with manganese content of over 45 per cent.

Beneficiation of low grade ore for export promotion and import substitution. In terms of tonnage the available manganese ore reserves in the country are quite high. Most of the known deposits however are either low in manganese content or high in impurities, with the result that ore of acceptable grade both for ferro-manganese industry and for export has to be obtained from a few sources only. Besides, even where ore of acceptable grade is obtained a large quantity of unacceptable ore is also produced. Therefore, it is essential that large scale beneficiation tests should be conducted on the manganese ore deposits situated in the various parts of the country. Pilot plant studies for this purpose should be immediately undertaken.

Some beneficiation tests have been carried out on dumps of low grade material containing 15-30 per cent manganese and 0.35-0.45 per cent phosphorus from Srikakulam and Visakhapatnam districts. The results so far obtained have not been encouraging. But effort should be continued.

In spite of known reserves of manganese ores in the country first grade manganese ore valued at 0.37 crore had to be imported in 1964. Intensive research is needed to explore the possibilities of upgrading and purification of indigenous ore to cut down the imports of first grade ore. Considerable research for the manufacture of electrolytic manganese dioxide from indigenous sources has been carried out in the country. Recovery of as much as 95 per cent manganese from low grade ores has been achieved with success. Commercial exploitation of these processes should be taken up immediately.

World market limited. Out of the total world trade of 4.7 million tons of manganese ore, the free market is limited to a meagre 2 million tons. The rest is being supplied by USSR, and from sources in Brazil and Africa that are jointly owned by the US, British, and French steel industries. MMTC have been exporting the manganese ore through link and barter arrangements, and are continually renewing the policies to increase exports. These efforts should be further intensified.

Ferro-manganese. Export of finished and semifinished products would be more beneficial for the country rather than the export of raw ores and the export of ferro-manganese of high standard should be encouraged.

Mica

Production and export. India is the chief supplier of block mica to the world market. During 1964, India produced 21,700 tons of mica valued at Rs 2.1 crores and exported about 30,000 tons of mica valued at Rs 9.8 crores.

Problems of mica industry. The problems of mica industry are twofold : first to boost up export of mica and its products and secondly to increase the internal consumption of all varieties of mica and fuller utilisation of waste or the scrap mica.

Manufacture of mica products. Mica trade and industry in the country have largely been dealing with crude mica and mica processed by simple methods. Substantially larger sums could be earned in foreign exchange if components and semis manufactures out of mica are exported instead of simply processed mica. Technical know-how for producing semis and components, and also the export market should be assessed.

MINING GEOPHYSICS

Present Status

Field investigations. During 1965, the Geological Survey of India carried out about 22 field investigations for various minerals and ores. The National Geophysical Research Institute carried out two reconnaissance geophysical surveys in relation to copper and iron, and has taken up a detailed geophysical survey for chromite.

In the field of petroleum, the Oil and Natural Gas Commission carried out 25 seismic and 12 gravity-cum-magnetic surveys.

Research. While no data are directly available, it is estimated that not more than 100 man-months were devoted to mining geophysical research in India during 1965.

Some of the Outstanding Problems

Inadequacy of field parties. It has been indicated that there is an immediate necessity for augmentation of production of ores and minerals by 50 to 100 per cent.

Assuming that the average duration for each of the 22 field investigations by GSI is five months, there has been a total of 120 man-months (including NGRI) of mining geophysical work in 1965 in India. As compared to this, Canada, for instance, has used 1700 man-months of mining geophysical work. Considering that Canada is about 4 times bigger in size than India, the above figures indicate that India's geophysical efforts in ores and minerals need to be stepped up three or four-fold. Even Australia, which is only about twice as large as India, has used 911 man-months of mining geophysical work during 1963. A substantial portion of the foreign activities is in the form of airborne methods.

Lack of indigenous geophysical instruments. Some 15 organisations at present use geophysical instruments for exploration, research, teaching, earth studies, etc. Oil and Natural Gas Commission, Geological Survey of India, and India Meteorological Department are the largest users. Almost all geophysical equipment now existing in India were imported from abroad, costing about Rs 138 lakhs in foreign exchange. Out of this, approximately Rs 66 lakhs have been spent during the past five years. The proposed import during the Fourth Five-Year Plan is estimated to be Rs 159 lakhs.

Nonavailability of geophysical equipment locally not only involves drain on foreign exchange reserve, but it also adversely and seriously influences opening of geophysical survey parties, research programmes, maintenance and repair of geophysical equipment etc.

Inadequate research. While India is now self-sufficient in turning out the required number of geophysicists, it is still greatly dependent on imported know-how for design and development of instruments, improved techniques of data handling and interpretation, evolution of new and modified field methods, etc. This is due to lack of serious and adequate research having direct impacts on exploration. A much greater research effort is necessary—much greater in proportion to the advanced countries already established in this line—to enable India to reach the take-off stage when it can be independent of outside help.

Recommendations

Augmentation of field parties. A hundred per cent increase is recommended.

Geophysics in ground water problems. Some ground water problems in which geophysical techniques can be fruitfully used are:

Mapping of water-table and bed rock topography.

Delineation of belts of saline water enrichment, especially in coastal areas.

Location of perched pockets of sweet water in a generally saline or brackish environment (in granular material).

Movement of ground water by radioactive tracer techniques.

Location of weathered zones in hard rock (granites, trap, etc.) country.

Location of permeable beds in deep bore holes.

Water quality surveys.

In the field of food and agriculture, adequate ground water supply can be assured only by a detailed assessment of our ground water resources. For such general surveys and for specialised problems as indicated above, it is recommended that ground water geophysics be strengthened considerably. At present, the Geological Survey of India, Central Water and Power Research Station, and the National Geophysical Research Institute, are the three organisations in India capable of undertaking such work.

Aerial geophysics. In order to cover large areas quickly and at lesser cost, the establishment of airborne geophysics is essential. This can also quickly demarcate areas according to degrees of mineral potential. Aerial surveys are also extremely useful in geological mapping over inaccessible jungle-covered areas.

Geophysical instrumentation. Considering the raw materials, components and know-how now available in the country, it seems possible to save nearly 60 per cent of the foreign exchange expenditure, if the balance is spent in purchasing mainly components and raw material rather than complete instruments. Many of the magnetic, electrical, electromagnetic and seismic instruments can be manufactured indigenously either wholly out of indigenous components and materials or by using some imported items.

It is very strongly recommended that the design and manufacture of geophysical instruments be taken up immediately, in all seriousness that it deserves. NGRI should take up development and manufacture of such instruments.

Offshore Geophysics. India has a long coast line with a very large shelf area. The mineral, ore and oil potential in the shelf areas are expected to be large. The Oil and Natural Gas Commission has two offshore seismic parties for petroleum exploration. One of these two is a party from the USSR costing a sum of Rs 60.00 lakhs per year.

Development of offshore magnetometers, ocean-bottom scintillators, apparatus for ocean-bottom resistivity and other electrical surveys, offshore seismic surveys, ocean-bottom coring, etc. is necessary. This has to be supported by investigation into the offshore field techniques, data processing and interpretation peculiar to offshore work. Offshore geophysics can be taken up in collaboration with the Institute of Oceanography, which plans on procuring an ocean-going vessel for oceanographic studies.

Geophysical research. The capacity for geophysical exploration research needs to be enhanced by about 200 per cent. The outstanding lines of work are:

Development of geophysical exploration techniques for deep exploration.

Development of underground geophysical prospecting techniques.

Interpretation methods for surveys carried out on non-flat topography.

Model and theoretical studies in electrical and electromagnetic methods.

Application of seismic methods to mining problems.

Data processing techniques.

Operations research in the field of minerals and ores.

Use of information theory in geophysical data interpretation.

OCEANOGRAPHY

Resources of the Oceans

Oceans cover more than 70 per cent of the entire surface of the globe. The living resources of the sea include fishes both in the inshore and offshore areas and the vast amounts of plants and other animals. Among the non-living resources are included the minerals including petroleum and salt present in sea water as well as in the bottom deposits.

Oceanographic studies can be profitably directed to:

(i) increase our sea food resources
(ii) exploration and exploitation of mineral deposits including petroleum
(iii) aid in reducing the shipping costs by improved routing

The marine minerals could be broadly classified as:

(a) those present in solution as sea salts

(b) those present in the near shore sediments and sands and are almost a continuation of the beach deposits

(c) those present in rocks or consolidated sediments on the continental shelves

(d) shell limes such as corals, etc.

(e) those present in the great depths of the ocean as concretions or nodules.

Petroleum Potential

The Indian subcontinent has a very large coastline and a large area is covered by the continental shelf. In most parts, the geology of the shelf is not known with any definiteness. For example, it has been suggested that the western coast of India was formed by down-faulting to the west, possibly during the early to middle Miocene times in which case a fair thickness of Upper Tertiary and Quaternary sediments may be present in the offshore area of this region.

Exploration for Petroleum

The broader areas of the shelf of India can be considered as having some petroleum potential in varying degrees. Aeromagnetic and shipborne magnetic surveys may be useful as a preliminary step to selecting areas where seismic work could be undertaken in greater detail.

Thorium and Rare Earth Potential

Beach sands containing thorium and rare earth metals are known to occur along the south Kerala coast and in some other coastal regions. It is possible that larger deposits may have developed by the sorting and reworking action of waves, tides and currents in some parts of the near shore area.

The coast of Kerala is being eroded away at a fairly fast rate. In order to conserve the mineral resources found along this coast and to save the land erosion it is essential that systematic oceanographic studies be intensified.

Phosphate Potential

Phosphates have been found to occur in certain offshore areas such as off the coast of Southern California, and it will be worthwhile to explore the possible occurrence of this mineral on the continental shelves off our coasts.

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10. Petroleum Refining, Petrochemicals, Petroleum Technology and Oil & Gas Exploration

The primary aims of the 'get-together' between representatives of Research and Industry are:

1. To assess and identify the problems facing different sectors of Indian industry and economy.
2. To arrive at the best methods of solving the problems.
3. To work out clear programmes and lines of collaboration between industry on one hand and research and development on the other, to implement solutions to problems.

These aims are set against the background of maximising aid to defence requirements, import substitution, export promotion and raising food and agricultural output.

The problems facing the Indian petroleum and petrochemical industry are to be viewed in this contest, and are discussed under the following heads:

1. Exploration for oil and gas, drilling and production.
2. Refining of crude oil and distribution, marketing and utilisation of petroleum products.
3. Petrochemicals and petrochemical end-products.

Before discussing the problems under each head, it is worth mentioning in summary, that the consumption of petroleum products in India increased from about 2.8 million tonnes in 1949 to 5.3 million tonnes in 1956 and over 11 million tonnes in 1964. The refining capacities, production and import of crude and products and anticipated targets for future are given in Table 1.

In the post Second World War period, industrial growth in developed countries has become vitally dependent on the increasing use of petroleum products as source of energy and chemicals. India with its plans for rapid economic progress, cannot afford to lag behind in the use of petroleum products, if it has to maintain the minimum desirable technological efficiency. The future demand for petroleum products is therefore bound to increase in spite of fiscal and other measures that may become necessary to curb consumption in order to conserve foreign exchange resources. This makes it imperative that efforts should be intensified in future to discover and exploit indigenous sources of crude oil, expand and ensure maximum utilisation of indigenous refining capacity and reduce imports of finished products.

The suggestions made in the papers submitted to the Working Group will now be summarised and some important problems facing the country will be discussed.

MEETING OF WORKING GROUP 10

Table 1 — Production, Consumption, Import and Export of Crude Oil and Petroleum Products in India

(million tonnes)

	1949	1951	1954	1956	1961	1964	1966 (est.)	1971 (est.)
1. CRUDE OIL								
1.1 Production	0.26	0.26	0.3	0.3	0.5	2.2	4.5	10
1.2 Imports	nil	nil	0.5	3.8	6.0	6.8	8.8	17
1.3 Throughput in Indian Refineries	0.26	0.3	0.8	4.1	6.4	8.9	13.3	27
2. PETROLEUM PRODUCTS (including lubricants)								
2.1 Consumption	2.8	4.0	4.3	5.3	8.5	11.3	14.0	25
2.2 Production	0.22	0.25	0.7	3.9	6.1	8.4	12.5	25
2.3 Imports	2.6	3.7	3.6	1.8	2.6	3.4	2.0	—
2.4 Exports	nil	nil	nil	0.4	0.2	0.5	0.5	—

Exploration for Oil and Gas, Drilling and Production

The first oil discovery in the Indian subcontinent was the Digboi oilfield in Assam in 1889. Soon after, another small field was discovered in the Potwar plateau, now in West Pakistan. Prior to the Second World War exploratory drilling was continued in the exposed anticlines in the foothills of Assam and in the Potwar area, but with limited success and no further major discovery was made. Thus, at the time of partition, India was left with only the Digboi oilfield with a small production.

In the post-war years discoveries of oil/gas fields have been made in the foreland shelf region of the Tertiary geosyncline of Assam and the alluvium covered basin of Cambay in Gujarat. The present proved and indicated reserves in Assam and Gujarat areas are of the order of 150 million tonnes.

Many of these discoveries have been made possible due to the development and refinement of new exploration tools, particularly in the field of seismic instrumentation and due to improvements in drilling equipment, particularly the increased capacity of the rigs. Apart from the technical factors, success in exploration is due to the aggressive exploration policy adopted by the Government of India which set up a special organisation (the Oil and Natural Gas Commission) in the public sector and Oil India Corp. Ltd in partnership with private sector, to carry out the task of exploring for oil and gas on a countrywide scale and the development of the resources. For exploration and development of oil and gas fields (as apart from setting up of refineries and trunk pipelines), the Government of India alone have incurred a gross expenditure of Rs 162 crores in the post-war years which has enabled establishment of recoverable reserves valued at many times the expenditure incurred.

The production in the Gujarat State at present is about 2 million tonnes of crude oil per annum, equivalent to a gross annual sale value of

Rs 16 crores. The production is expected to be increased to nearly 3 million tonnes per annum in about a year.

In addition to crude oil, natural gas (associated and non-associated) is presently being produced at the rate of about 200,000 million cu.m. per annum from Gujarat. The gas is being utilised as a fuel for power generation at the Uttran Thermal Power House and the Dhuvaran Thermal Power House of Gujarat State Electricity Board. Gas will also be available for use in industries around Baroda and as fuel and feedstock for the fertiliser plant being set up near Baroda. The importance of fertilisers in the present day agriculture needs no emphasis.

The implications of these discoveries are manifold :

(i) Indigenously produced crude displaces equivalent imports of crude, saving foreign exchange.

(ii) Providing raw material for petrochemical industry.

(iii) Relieving a heavy burden on the railway rolling stock, otherwise required for conveying coal over distances varying from 1000 to 2000 km. from fields of Bihar, Madhya Pradesh, etc., to the above-mentioned power stations, fertiliser plants and other industries.

(iv) Providing employment in the oilfields, refinery, petrochemical, fertiliser and ancillary industries.

(v) Building up of a cadre of competent technicians, scientists and design engineers.

The Oil and Natural Gas Commission's discoveries in Assam have yet to reach a stage of commercial exploitation which is however expected to be achieved soon.

The Commission is exploring for oil and gas in all the important sedimentary basins in India which is expected to lead to further discoveries.

In order to achieve the targets set, the Commission requires a wide variety of equipment, a major part of which is currently being imported at high cost. To save this outflow of foreign exchange, the Commission has taken certain steps to promote indigenous manufacture of many items. The following information will be of interest in this context.

(i) Apart from capital equipment required for drilling, major expenditure incurred is on importing tubular goods, e.g. casing of various sizes, drill pipes, tubings, etc. (valued at about Rs 20-25 crores for the Fourth Plan period).

The Commission is negotiating with the Indian Tube Company for the manufacture of certain types of casing and tubing to be manufactured in India.

The Commission is also considering collaboration with or independently setting up of a pipe mill for the manufacture of casing, tubing and drill pipes, etc.

(ii) The second major expenditure is in the import of high pressure valves and system of valves (approximate value Rs 4 crores).

Some firms in India have started manufacture of high pressure valves in certain sizes and pressure ranges.

To the manufacturers/firms collecting information on the Commission's requirements of high pressure valves, etc., Commission has provided its requirements and/or otherwise help by discussions.

(iii) The Commission has set up a design organisation (DMU) which prepares designs of fast wearing parts of drilling and ancillary equipment and helps in having these manufactured indigenously.

(iv) Hind Oil Design Institute prepares detailed drawings and designs of equipment required for surface installation in oilfields and gives such designs to local manufacturers.

(v) The Instrumentation section of the Research and Training Institute and the Geophysical laboratories have been designing instruments and fabricating prototypes of instruments, e.g. parts of seismic units, electric logging units, shot hole rigs, which are being imported at present.

Paper 10.5 by Oil India Ltd presents a case for setting up an indigenous oilfield equipments industry. The paper discusses the steps required for the manufacture of a wide variety of oilfield equipments such as diesel engines, derricks and substructures, blow-out preventers, drill pipes, casing and tubing, high pressure pumps and compressors. The paper recommends that the Heavy Engineering Corporation, Ranchi, should undertake design and fabrication of most of the above equipments. Indigenous availability of suitable steels is considered and methods of inspection of equipment during the course of fabrication are recommended.

It is learnt that the Heavy Engineering Corporation is fabricating drilling rigs for the ONGC. It is to be considered whether the capacity of the HEC is adequate to meet the entire requirements of the oil production industry or whether additional organisations have to be set up. As noted above, the ONGC is establishing design and manufacturing units, in collaboration with other organisations, to manufacture special parts. It is to be considered whether these units can and are proposing to meet the requirements also of Oil India Ltd.

Paper 10.6 by Oil India Ltd discusses the need for indigenous manufacture of special oilfield chemicals which are of proprietary nature and being imported at present. Many of these chemicals are essential for deep drilling, though in small quantities. In view of the necessity for resorting to deep drilling in India, the indigenous manufacture of these chemicals assumes added importance. Some of the lignosulphonates can be produced from waste liquors from paper industry. It would be necessary to develop adequate process know-how and oraganise proper and full utilisation of the waste liquors. Similarly, process and development know-how have to be developed for production of surface active agents which are being imported. Although used in small quantities, ready availability of these chemicals is vital for the success of oilfield operations.

Paper 10.7 compares two methods of providing oil-well cements, either by controlling the characteristics of portland cement during its manufacture or by treating conventional portland cement with additives. The authors feel that improvement in the quality of the cement by changing the phase composition of the clinker during manufacture is the better answer. They refer to the present usage of special cements manufactured in India by ACC developed in collaboration with ONGC, and opine that with more research and development work, it is possible to produce different types of oil-well cements from indigenous raw materials. It is therefore apparent that the special cements can be manufactured in India with proper collaboration between user and manufacturing organisations.

Refining of Crude, Distribution, Marketing and Utilisation of Petroleum Products

In all three papers have been submitted under this category.

Paper 10.1 refers to indigenous manufacture of catalysts. Catalysts are essential chemicals in very many refining and petrochemical manufacturing processes, and practically all of it is now being imported. Hence it is of utmost importance that efforts should be made for manufacturing them indigenously.

Considerable work has been done over many years on the development of catalysts for special processes in several research and educational institutions in India. However, as far as is known, no indigenously developed catalyst has reached the stage of commercial application. It is worthwhile examining the reasons for this situation and the problems involved in this regard.

Recent progress in this field is:

1. A detailed market survey has been carried out by the Indian Institute of Petroleum and the Central Design & Engineering Unit of the CSIR. This survey has estimated in detail the demand by the fertiliser and refining industries, which has been placed at 1500 tonnes/year during the Fourth Plan period.

2. An Indian firm has approached the Government for a licence to manufacture a wide range of catalysts. However, this firm is using imported know-how.

It is apparent that a more purposeful effort is required to develop catalysts for commercial use in competition with imported products. It may be mentioned here that it is not enough for a research worker to quote yields and concentrations of catalyst in his research paper. He should provide the process designer sufficient information for a full evaluation. For example, some of this data are bulk density, size range, mechanical properties such as crushing strength and attrition, regeneration schedule and guaranteed life. If desired, the Indian Institute of Petroleum can prepare a proforma listing the data required for the commercial evaluation of a catalyst.

Papers 10.3 and 10.4 both by the CFRI deal with hydrogenation of aromatic extract and straight-run kerosine respectively produced from the Nahorkatiya crude oil. The problems of maximising production of superior kerosine and disposal of extract from the SO_2 units are well known. The solution offered by the authors in paper 10.3 is extraction of straight-run kerosine using the SO_2 extraction unit to yield superior kerosine, and hydrogenating the resulting aromatic extract to yield a marketable product. In paper 10.4, the proposal is to directly hydrogenate the straight-run kerosine and raise its smoke point. In this case, the existing SO_2 units will become redundant. In both cases new facilities will have to be built to hydrogenate the streams as well as for the production of the necessary hydrogen. This will call for considerable fresh capital expenditure, and a detailed economic evaluation is necessary.

There are in fact one or two more solutions to the same problem. For convenience the possible solutions have been shown diagrammatically in Chart 1. The third solution is that of selling the inferior kerosine as such. It is very doubtful if all this can be marketed in the economic supply areas available to these refineries. The last solution suggested is use of lamps and cooking appliances which can burn the straight-run kerosine as efficiently as superior kerosine can be burned. Thus it is seen that there are several solutions suggested and only a detailed economic evaluation can indicate the best solution.

It may not be out of place to mention here that the Indian Institute of Petroleum have also done work on hydrogenation of petroleum fractions and a commercial process has been offered to the Madras Refinery Project.

Paper 13.1 on jet fuels from coal by CFRI may also be considered here since it has some relevance to the petroleum industry. The authors are of the opinion that high energy fuels suitable for supersonic aircraft can be produced by hydrogenation of fractions of coal-tar from high temperature carbonisation of coal. Though one might say that supersonic aircraft of even Mach 2 use kerosine and special high energy fuels will be required only for aircraft flying at still higher speeds or for rockets, in view of the importance of such fuels in the future, the commercial feasibility of the project should be worked out immediately.

There are several other major problems not covered by the papers presented. Some of these have already been referred to in a paper by Dr M. S. Ayengar (not for circulation). These are mentioned here.

Manufacture of Additives

A licence has been issued for the manufacture of additives. The Indian Institute of Petroleum is developing know-how for manufacturing additives not covered in the above licence. However, there is plenty of scope for research in this field, especially for the production of synthetic lubes for jet aircraft.

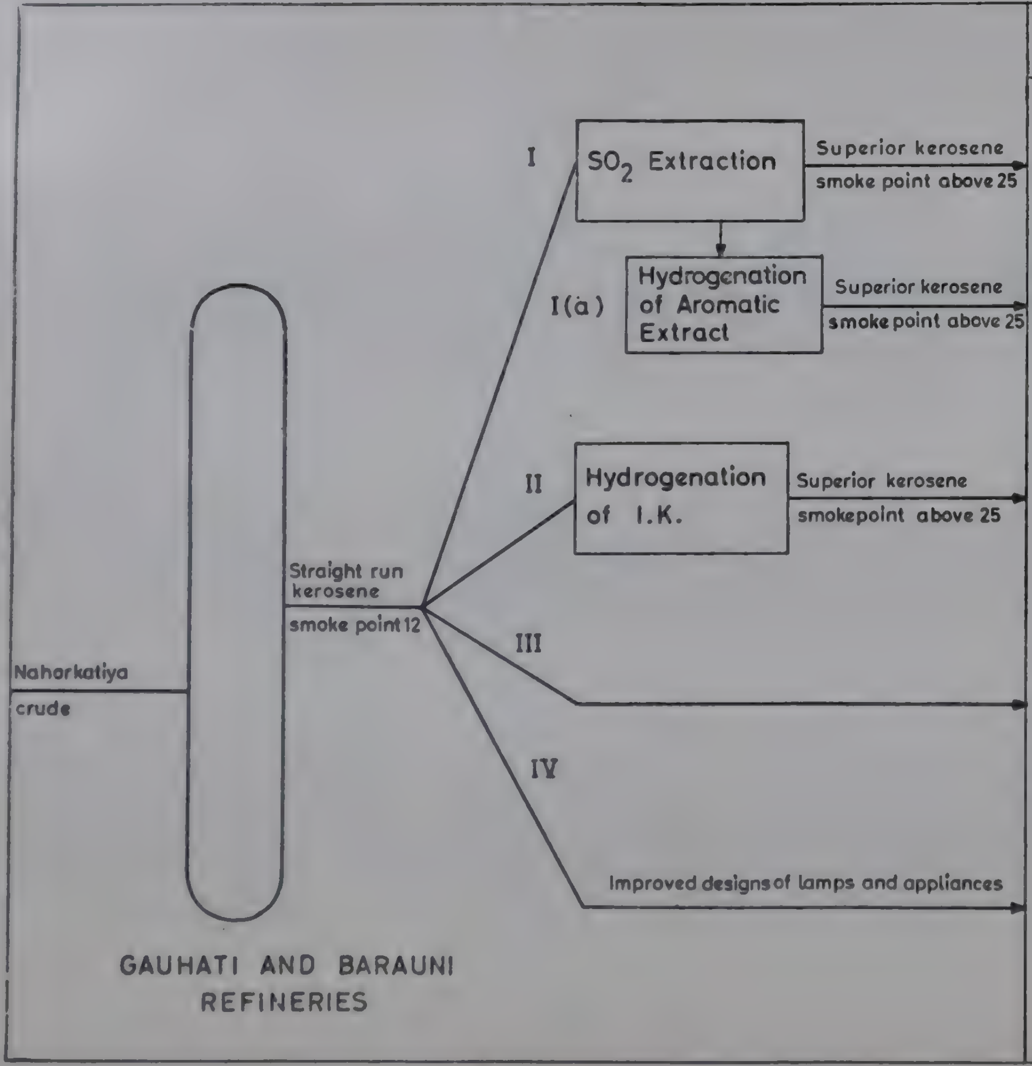
Secondary Recovery of Oil

It is of utmost importance that the maximum amount of crude oil in place should be recovered, and with this end in view, steps for secondary recovery should be initiated even during the early part of the life of the oilfield. However, this can lead to increased rate of production in the immediate future only if down-stream facilities such as for transportation of crude and refining are also developed simultaneously.

Full Utilisation of Assam Crude

Utilisation of Assam crude has kept pace with the capacity of the Digboi, Gauhati and Barauni refineries. Steps are afoot to expand the capacities of Gauhati and Barauni refineries. This can be facilitated if the problem of high pour point fuel oil produced by the Barauni refinery can be solved. The major problem is that of consumer acceptance. An alternative solution is secondary processing of this fuel oil to yield middle distillates. Research in this field may be undertaken to develop a commercial process for this conversion.

A few problems of interest are given below.


Naharkatiya
crude
GAUHATI AND BARAUNI REFINERIES
Straight run kerosene
smoke point 12
I
SO_2 Extraction
Superior kerosene
smoke point above 25
I(a)
Hydrogenation of Aromatic Extract
Superior kerosene
smoke point above 25
II
Hydrogenation of I.K.
Superior kerosene
smokepoint above 25
III
IV
Improved designs of lamps and appliances

PROBLEM	SOLUTION OR ADVANTAGE	ECONOMIC IMPLICATIONS
Insufficient quantity	(a) Existing lamps can be used to give desired illumination.	
Difficult disposal ; low return(when sold as furnace oil or feedstock for carbon black.)	Partly satisfies furnace oil demand when sold as such. Additional quantity of S.K. available for use in existing lamps and cooking appliances. Reduces import of S.K.	Additional investment for hydrogen production and hydrogenation. Additional processing cost. Higher returns.
	Maximum quantity of S.K. available for use in existing lamps and cooking appliances. Reduced import of S.K.	Additional plant investments for hydrogen production + for hydrogenation [larger capacity than I (a)]. Additional processing cost. Higher returns. Redundancy of existing extraction plants and investment.
1. Existing lamps cannot be used for desired illumination. 2. Demand for S.K. not satisfied in the region S.K. imports increase. 3. Not enough demand for all I.K.	No lomex disposal problem.	Lowest returns to refinery. Redundancy of existing plant and investment.
	1. No lomex disposal problem I.K. can be used in improved lamps in place of S.K. 2. Cheaper kerosene to the consumers.	

CHART 1—PROBLEM OF INFERIOR KEROSENE: ALTERNATIVE SOLUTIONS

Lubricating Oil Regeneration

In addition to indigenous manufacture, efforts should be made to conserve and reclaim the maximum of used lubricating oils. This is being widely practised in France, Germany, Egypt, etc. and the processes are simple and well known. Immediate steps should be taken to build reclamation plants. Organisations such as Indian Institute of Petroleum, Defence Research Laboratories, etc. are known to have developed processes and successfully designed and operated plants using their processes.

Standardisation and Quality Assessment

It is well known that standardisation is an inexpensive means for avoiding wastage. Proper standardisation, quality control and laying down of specifications can cut down inventory, conserve material and in many other ways lead to savings. For several petroleum products, such as lubricating oils, till recently it was necessary to get test certificates from abroad. Very soon all the lubes will be made indigenously, and to avoid paying in foreign exchange for test certificates, establishment of facilities for indigenous quality assessment has become necessary. The Indian Institute of Petroleum and the Defence Research and Development Organisation have now facilities for most of this type of work.

Proteins from Petroleum

Attempts are being made in many countries to produce proteins from petroleum, especially petroleum wax. In India, this process has added significance in the context of availability of surplus paraffin wax and the fact that the average Indian diet is deficient in proteins. Efforts of RRL, Jorhat, in this direction are reported to have met with success. However, every effort should be made to accelerate research and development in this field.

Fatty Acids from Petroleum Wax

In the context of high prices and nonavailability of vegetable oils, it is essential that other sources for fatty acids should be developed. Production of these acids from petroleum waxes has been developed in several foreign countries. In India, petroleum wax is largely surplus and provided a commercial process is developed, it can be utilised for making soap, saving vegetable oils which can then be diverted for edible purposes.

Petrochemicals

The petrochemical industry in India is still in its infancy. Whatever industry existing today is based on non-petroleum raw materials like alcohol, calcium carbide, etc. In developed countries these raw materials have been largely replaced by suitable petroleum fractions for reasons of economy and technology, and the trend in this country is also along these lines.

The problems of petrochemical industry are mainly:

1. Technical know-how for processes
2. Equipment
3. Organisations to undertake design and construction

Presently, we depend on foreign countries for all these. Dependence on imported know-how and equipment is going to result in high product prices which will reduce our competitiveness in foreign markets. Hence there is urgent need to develop indigenous know-how and equipment not only to make us self-sufficient but also sell our products abroad.

The major fields to be considered are:

1. Synthetic plastics
2. Synthetic rubber
3. Synthetic fibres
4. Synthetic detergents

There is no need to emphasise the importance of the above products in the national economy.

The first step is to develop know-how. Research should be undertaken both in national laboratories and industrial organisations. Petrochemical processes and know-how go obsolete in very short time and only extensive and productive research can enable us to remain competitive.

There is urgent need to manufacture equipment indigenously. This is especially true for the conversion industry as will be seen later.

Thirdly, steps should be taken to create cells of competent technical people to design and construct plants. ~

Conversion Industry

It is not always realised that the conversion industry (converting petrochemical intermediates into finished consumer goods) is almost as important as the basic raw material industry. The main problems here are equipment and new designs to cater to continuously changing market. These factors should decide the lines of research in this industry.

The existing state of this industry compares poorly with that in developed countries. A good part of the equipment that are used are crude and non-standardised, especially in smaller units. A major bottleneck in replacing these is that sophisticated equipment have all to be imported. Steps to manufacture the equipment indigenously are being taken and a few units are in the process of being set up. Especially in the synthetic fibre conversion industry, we depend almost entirely on imported equipment.

WORKING GROUP 11 IN SESSION

11. Energy, Coal

The country is passing through a serious foreign exchange crisis accentuated by the recent aggression on our borders and the need to import substantial amounts of foodgrains and fertilisers. India's foreign exchange balance stood at Rs 1,800 crores in 1947 but now we have a foreign debt of Rs 2,500 crores. Our foreign exchange resources in November 1964 stood at less than Rs 85 crores despite a drawal of Rs 47·6 crores from the International Monetary Funds since April 1965. Our commitments on the other hand have been on the increase. During the Third Five-Year Plan, Rs 500 crores had to be paid by way of capital repayment and interest and during the Fourth Five-Year Plan, the country's external obligations are estimated at Rs 1,100 crores—Rs 600 crores by way of capital repayment and Rs 500 crores by way of interest.

We are on the verge of completing the first phase of the three Five-Year Plans and are envisaging an investment of Rs 21,000 crores during the Fourth Plan and Rs 34,000 crores during the Fifth Plan. This is expected to increase the per capita income from the present Rs 350 to only Rs 597 by the end of the Fifth Plan, and the economy of the country would have increased at the rate of 7 per cent.

The expansion during the Fourth and the Fifth Plan is based on substantial foreign aid and only in 1975/76 it is envisaged that the foreign aid would become nil. The total requirement of capital equipment including replacement is expected to increase from Rs 10,500 crores in 1965/66 to Rs 18,075 crores by 1970/71 and Rs 29,000 crores by 1975/76. The domestic output of the finished machinery at the end of the Third Plan is expected to meet about two-thirds of the present total demand. Based on various considerations, the foreign exchange gap is placed at Rs 2,500 crores at the end of the Fourth Plan.

The growth of industrial production envisaged in the programme would require a large expansion in the output of fuel and power. The total requirement of coal is estimated to increase from the 68 million tons at the end of the Third Plan to 117 million tons at the end of the Fourth Plan. The power requirements are estimated to increase from 11 million kW. to 22 million kW. and the petroleum products from the present 14.6 million tons to 26·7 million tons. The total investment on the generation of power alone is expected to be Rs 2,000 crores during the Fourth Plan and the investment on the entire energy sources is expected to be over Rs 3,500 crores, bulk of which would be in foreign exchange. In addition, the requirements for maintenance, including spare parts, on the existing installations, is expected to be of the order of Rs 105 crores. In view of such a high investment, it has become necessary to see if the dependency on foreign imports could be minimised by accentuating the production of indigenous capacity and by import substitution in various sectors.

The objective of the Working Group on Energy should be to assess the magnitude of the energy development problems, indicate the present gap and what is more, specifically outline the work required to be done by the research institutions and other organisations to attain self-sufficiency.

Energy Requirements

Over 60 per cent of the total energy of the country is derived from non-commercial sources—fire-wood, waste products, and cow-dung. Fire-wood alone provides about 40 per cent of the energy used in the country. More energy is consumed in the form of cow-dung than in the form of electricity. The recent trend of energy consumption estimated by the Energy Survey Committee is given in Table 1.

The non-commercial forms of energy present a number of special problems of their own. The cow-dung, though it provides a cost-free and attractive fuel, could have been used as fertiliser rather than fuel. The fertiliser value of cow-dung (assuming 0·3 per cent nitrogen content), burnt as fuel is equivalent to 0·82 million tons of ammonium sulphate or Rs 25 crores in foreign exchange. The 100 million tons of timber burnt as fire-wood will exceed the total annual growth of suitable timber and, therefore, lead to deforestation, soil erosion and floods. On flood control alone, each year the country is spending over Rs 50 crores.

The energy consumption in India expressed in terms of indigenous primary sources and imports is given in Table 2. It would be seen that

Table 1—Recent Trends of Energy Consumption

(Energy consumption in India in terms of primary sources measured in original units)

	Commercial fuels			Non-commercial fuels		
Year	Coal (million tons)	Oil (million tons)	Hydro-power (TWh)	Dung (million tons)	Fire-wood (million tons)	Veg. wastes (million tons)
1955-56	35.1	4.4	3.7	48.8	88.8	27.7
1960-61	49.9	6.7	7.8	54.0	100.0	30.7
1962-63	59.6	8.5	11.8	54.9	101.6	31.1

Table 2—Energy Consumption in India Expressed in terms of indigenous Primary Sources and Imports

(million tons of coal replacement)

	Indigenous production							
Year	Coal	Oil products from indigenous crude	Hydro-power	Non-commercial energy	Total	Net import	Total consumption	Net import % of total consumption
1955-56	38.9	2.3	3.3	130.3	174.8	24.9	194.2	12.8
960-61	55.5	3.1	6.8	146.1	211.5	38.7	242.5	16.0
962-63	64.9	7.7	10.4	148.2	231.3	45.4	270.6	16.8

the net imports totalling over 16 per cent mainly on oil products, continue to increase each year.

The distribution by region of population, industry, energy consumption, as worked out by the Energy Survey Committee is given in Table 3. Coal and oil resources are predominantly concentrated in the North-East part of India. Bihar, Orissa, West Bengal and Assam contained in 1960/61 only 26 per cent of the population of India and produced only 33 per cent of the total output of the factories covered by the Survey of Industries. They took about 35 per cent of the energy consumed in India and 34 per cent of electricity. In the Southern and Western regions, containing 39 per cent of the population of India, produce 53 per cent of the factory output and absorbed in 1960/61 about 41 per cent of all energy and 47 per cent of all electricity. The Southern, Western and Northern regions, which are remote from the coal fields contained 5/6th of the Nation's hydel production. It is the problem of creating a modern energy-based economy in these regions, at a considerable distance from indigenous supplies of coal and oil, though well endowed with hydel potential that needs careful consideration. The demand for primary sources of energy as estimated by the Energy Survey Committee is given in Table 4.

The Problem of Power Generation

Based on a 7 per cent growth in National income the Energy Survey Committee have suggested a power target of 21·4 million kW. for 1970-71 as against the Planning Commission's target of 22 million kW. and the Central Water & Power Commission's target of 23 million kW. This is expected to increase during the Fifth Plan period to 33·9 million kW. as against the Planning Commission's target of 39 million kW. and C.W. & P.C. target of 40 million kW. The production capacity per annum from the indigenous by manufactured steam turbine generators at present is only about 50 mW. and the integrated production for the entire Fourth Five-Year Plan is only 3,652 mW. The production potentialities of Bharat Heavy Electricals have been very ably discussed by Swayambu and Krishnamurthy, in their paper presented to the Session. With the developments envisaged at Bhopal, Hardwar and Hyderabad, the total annual manufacturing potential that will be created for thermal and hydro-generation by the end of the Fourth Plan is 3,500 mW. and 1,700 mW. respectively. This capacity would be sufficient to meet the expansion requirements suggested by the Planning Commission and the Energy Survey Committee for the Fifth Five-Year Plan. The major requirements of power during the Fourth Five-Year Plan, however, will have to be met from imported machinery and it is understood that firm commitments have already been made with foreign firms for increasing the power production from the present 12 million kW. to about 19 million kW. Bharat Heavy Electricals have the capacity to provide the additional 3·6 million kW. to achieve the plan target. However, consideration should be given to see if the production targets of the Bharat Heavy Electricals could not be accelerated.

The planning of the Bharat Heavy Electricals was done in 1954 with extremely conservative estimates. Subsequent review, prior to the Third Plan, indicated that the demand for power generation would show an annual increase of 2 million kW. in 1965/66. It was then decided in 1960 to set up two Heavy Electrical factories at Hardwar and Hyderabad for the manufacture of hydro and steam power stator equipment and a high

Table 3—Distribution by Region of Population, Industry, Energy Consumption and Production

Region	Population	Factories covered by Survey of India by		Consumption in 1960-61		Production 1960-61		
		Employment	Value added	Commercial energy	Electricity	Coal	Hydel	Oil
	1961	%	%					
1. Eastern (Bihar, Orissa and West Bengal)	22.5	29.5	30.4	32.0	33.7	80.4	10.1	—
2. Northern (Punjab, Rajasthan, Delhi, Jammu & Kashmir, and Himachal Pradesh)	11.0	5.6	4.7	9.2	8.5	0.1	13.0	—
3. Central (Madhya Pradesh and Uttar Pradesh)	24.2	11.0	8.8	15.2	10.5	12.1	6.0	—
4. Western (Maharashtra and Gujarat)	13.7	31.3	37.8	23.0	23.5	1.5	17.6	—
5. Southern (Madras, Kerala, Mysore and Andhra Pradesh)	25.3	20.3	15.2	18.0	23.6	4.6	53.0	—
6. Assam	3.3	2.4	3.0	2.5	0.3	1.3	0.3	100
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100

Table 4—Demand for Primary Sources of Energy

(in original units; in million tons)

	1960-61	1970-71	1980-81
1. Coal for electricity			
*Case 1	9.1	16.5	39.3
Case 2	9.1	19.0	49.3
Case 3	9.1	24.4	60.9
2. Coking coals			
Case 1	11.6	21.0	47.1
Case 2	11.6	24.3	62.1
Case 3	11.6	31.4	80.1
3. Non-coking coal			
Case 1	28.8	44.6	76.0
Case 2	28.8	49.3	90.0
Case 3	28.8	57.2	105.3
4. Lignite			
Case 1	—	1.8	6.6
Case 2	—	3.7	6.6
Case 3	—	3.9	6.6
5. Oil products for electricity			
Case 1	0.4	0.9	2.4
Case 2	0.4	1.0	3.0
Case 3	0.4	1.1	3.7
6. Oil products			
Case 1	6.0	14.5	34.8
Case 2	6.0	15.8	41.9
Case 3	6.0	17.8	49.2
7. Hydro (TWh)			
Case 1	7.7	34.6	56.6
Case 2	7.7	34.9	65.4
Case 3	7.7	36.1	76.6
8. Nuclear			
Case 1	—	3.9	20.4
Case 2	—	3.9	26.3
Case 3	—	3.9	32.8

*Case 1, 5 per cent increase in national income.
Case 2, 6 per cent increase in national income.
Case 3, 7 per cent increase in national income.

pressure boiler manufacturing unit at Trichy. Later in 1964/65 sanction was accorded for a specialised manufacturing unit at Hyderabad for Circuit Breakers up to 400 kV. The manufacturing potential expected to be reached by the end of Fourth Plan of all the three units of Bharat Heavy Electricals is given in Table 5.

Table 5—Manufacturing Potential of Bharat Heavy Electricals by the end of Fourth Plan

Plant	Steam turbine and generators	Hydro turbine and generators	Power Transformer	Circuit breakers
1. Bhopal	1200 mW.	500 mW.	3000 mVA. to be increased to 6000mVA. in Fourth Plan period	11 kV. 1900 Nos. 33 kV. 300 ”
2. Hardwar	1500 mW.	12 mW.		66kV. 100 ”
3. Hyderabad	800 mW.	nil		132 kV. 100 ” 220 kV. 100 ” 400 kV. 40 ”

There are at present two boiler manufacturing units, namely A.V.B. at Durgapur with an annual capacity of 0·35 million kW. and Heavy Electricals in Trichy with an annual capacity of 0·75 million kW. The production during the Fourth Plan from these two units is expected to match the production of steam turbines from the Heavy Electricals. Both the A.V.B., Durgapur and the Trichy factory can be expanded to increase their output to 0·5 million kW. and 2 million kW. per annum respectively. As the production of steam turbines from 1972/73 onwards will exceed from 2·5 million kW. per annum increasing to 3·5 million kW. perannum, during 1975/76 onwards, it will be necessary to set up additional boiler-making plants to meet the gap of 1·0 million kW. per annum.

Even under the present programme of production several essential components are still to be imported. These imports are mainly for manufactured components and for raw materials. The reduction in the first item could be effected by undertaking the maximum components manufactured in the main factory itself or preferably to subcontract as many small items as possible to accelerate the industry. There is need to accentuate the establishment of ancillary industries as it would be difficult for the Heavy Electrical factories to themselves undertake the manufacture of a wide range of components. With regard to the raw materials and intermediate products, most of the ferrous and other items are developed within the country. For example, a number of insulating materials are already available and considerable developmental work is being done at Bhopal for new products. Heavy Engineering Corp., Ranchi, may be in a position to supply a part of the requirements of larger castings and forgings. There are, however, certain items like special grades of covered copper, cold rolled silicon sheet steel, which may continue to pose problems and, therefore, may have to be imported. For generator stator, lamination silicon steel, of appropriate qualities, is not available. Similarly, alloy steel tubes for boiler manufacture, copper and brass tubes for condensers and coolers are difficult to obtain indigenously.

Although the modern tendency is to adopt cold rolled silicon steel for generator stator laminations, perhaps hot rolled sheets could also be used as is understood to be still done in the USSR. While research can be undertaken to indigenously establish cold sheet rolling facilities it might be worthwhile to sacrifice the quality to some extent and conserve foreign exchange adopting hot rolled steel sheets, till the cold rolling facilities are established.

Similarly, although facilities exist at the Rourkela Steel Plant for manufacturing boiler quality plates, this steel is to be imported as the steel plants do not find it economical to undertake their rolling. Boiler plates are required mainly by A.V.B., Durgapur and the boiler manufacturing plant at Trichy. The former has been installed in collaboration with a British firm and the latter in collaboration with a Czechoslovakian firm and, therefore, there is variation in the specifications. The difference, however, does not seem to be insurmountable and the Central Mechanical Engineering Research Institute, Durgapur and the ISI may be able to suggest methods for standardisation. The combined demand of the A.V.B., Durgapur and the Trichy plant might make it economical for the Rourkela Steel Plants to undertake rolling operation.

There is also a strong need to examine in detail the various accessories such as feed water pump, feed water heaters, water handling plants, instrumentation and control equipment, which are at present being imported.

The problems of indigenous manufacture of transformers, switchgears, wires and cables, static capacitators and other equipment are ably dealt with by Shri N. Venkatesan, in his paper presented to this Session. In the case of transformer industries raw materials like electrical sheet steel, copper, transformer oil, insulating paper and board and components like cooling tubes, high voltage bushings, top charging equipment, etc. are all being imported. The value of raw materials and components being imported is nearly 50 per cent of the sale value of each transformer.

The details of these imports should be scrutinised carefully by competent committee comprising representatives of the research laboratories, C.W. & P. C. and Heavy Electricals and substitutes suggested.

There is a shortfall of nearly 1·75 million kVA. per annum in the distribution transformers. This could be met by expanding the existing units or by establishing new units for further manufacture. Similarly, there is a need for augmenting the production capacity in circuit particularly the voltage cables, 66 kVA. and below.

Integrated Operation of Power Systems

While in a growing economy, the growth of power has to keep pace with the growth of industry, the need for conservation and improved methods of generation and distribution should not be forgotten.

The advantages of integrated operation of the power stations on one system and also inter-connection and pooling of power resources of different systems are well known but they merit recapitulation. Briefly, they relate to (a) economy in stand-by machinery, (b) ability to maintain continuity of supply even if a particular station fails, and (c) saving in generating capacity for meeting the same load due to diversity of load demand. This apart, integrated operation will help the shift towards resources oriented generation since large coal-fired stations with lower capital and working costs can be sited at the most economical points.

The United Kingdom has been able to save £ 150 million in extra power generating plants by inter-connecting the existing generating stations through the 275 kVA. super grid at a cost of only £ 78 million. Similarly, by inter-connecting the Southern and Central network in the European part, and by bringing into existence an inter-connecting grid of 30,000 mW. capacity the USSR was able to save power to the extent of 1,500 mW.

The saving that can accrue from integrated operation in India during the Fourth Plan is estimated at Rs 200 crores in respect of capital equipment and Rs 20 crores a year in operation and maintenance charges. Consideration should, therefore, be given to implementing the establishment of an all India grid and this should not be made to wait for the Fifth Plan. A beginning may be made by establishing five regional grids covering the entire country. The following regional boards could be formed:

1. The Southern Regional Electricity Board
2. The Northern Regional Electricity Board
3. The Western Regional Electricity Board
4. The Eastern Regional Electricity Board
5. The North-Eastern Regional Electricity Board

These Boards should be responsible for reviewing the progress of power development schemes in the regions, planning and ensuring integrated operation of systems in the region, coordinating the programme of maintenance of generating plants and determining the generating schedules and the quantity of surplus power available for exchange.

Standardisation

Standardisation of design of large thermal power station, E.H.V. transmission lines, sub-stations and rural electrification practice is another method of reducing investment cost. There is considerable scope for this approach in India. In the USSR, for example, it is stated that the types of tower for various lines have been reduced from 450 to 72 covering four voltages, viz. 110, 154, 220 and 330 kV. The emphasis in this case is not so much on the economy of support as such but on the overall economy achieved through ease of fabrication, ease in handling, transportation, storage and consequent acceleration in construction.

Extra High Voltage Transmission Line

Another field where economy can be achieved is in minimising the transmission losses by installing high voltage transmission lines. Power losses in a transmission line are a function of the impedance and square of the current. Thus, raising the voltage lowers the current proportionately, which helps compensate for increase in impedance with distance. The technical problems involved in their adoption to Indian conditions is worth studying. The highest voltage line currently in use in the country is 250 kV. (700 miles line as on March 31, 1962).

Transmission-Generation Ratios

Another important aspect which has not received sufficient attention is the need for matching the power generation with transmission facilities. In order to make optimum use of the generating capacity, the ratio of outlay on generation to that on transmission should be 5 : 4 whereas the ratio used so far is 2 : 1. We have been placing too much emphasis on generation to the neglect of transmission. The Energy Survey Committee has pointed out that in most advanced countries the investment in transmission and distribution is normally equal in size of the investment in generation. The imbalance in India has obviously been due to the anxiety to create maximum generating facilities within the allotted funds. The Energy Survey Committee has mentioned that the investment in transmission has now a high indigenous content and a low import content but investment in generation has much larger foreign exchange component.

It has to be realised that a given investment in generating capacity and main transmission line requires an even greater investment in complementing facilities such as sub-transmission, low-tension distribution and laying of services to factories and houses. It is necessary to ensure that the power generated is being properly utilised. For instance, rural electrification has been pursued with some vigour. But it is understood that the peasants are not fully utilising these amenities as they do not have the means of financing internal wirings in their huts and also not able to buy power at the prevailing price.

The planning of power requirements is normally based on the electricity balance of the various consuming industries. For instance, the electricity requirements are assessed using certain consumption norms for various industries like the iron & steel industry, ferro-manganese industry, alloy steel industry, aluminium, copper, coal-washing, petroleum refining, cement etc. The location of most of these industries are raw material oriented. On the other hand, the planning of power generation being the subject of the States may be done without fully taking into consideration the requirement of the industry. This mght be already resulting in some of the States having surplus power. This could be avoided by basing the power requirements in the industry-wise basis instead of State-wise basis. The consumption of power for domestic use is only 8 per cent. Seventy-six per cent of the bulk is being consumed by the industries. A detailed study should be undertaken to assess the utilisation factor in the existing power stations in India. Similarly, steps should also be taken to assess the boiler availability of the power station so as to obtain greater productivity. This can be done only by undertaking detailed fuel efficiency studies.

Problem of the Oil Industry

This subject is being discussed in detail by the Working Group 10. The discussion here would be mainly confined to the impact of oil on the other sources of energy.

The oil industry in India had a phenomenal growth. From a mere 2 million tons since 1947, it has increased today to 11 million tons. The expansion of the refining capacity has increased from 0·4 million tons to 9·5 million tons and the production of indigenous crude has stepped up from 0·42 million tons to about 2·5 million tons. There is no denying the fact that despite indigenous production and development of refining capacity the drain of foreign exchange continues to be on the increase. For instance, the import requirements of petroleum products are expected to increase from Rs 98 crores in 1966 to Rs 107 crores during 1970. The total foreign exchange requirement during the Fourth Plan is estimated to be Rs 487 crores. The imports are mainly for kerosene/A.T.F., fuel oils, lubricants and crude oils. The investment envisaged during the Fourth Plan for oil exploration as well as for refining including installation of the lubrication oil plant is estimated to be Rs 631 crores, out of which the foreign exchange component will be over Rs 126 crores. The oil production is estimated to increase to 29·5 million tons. The sector-wise consumption of petroleum products is given in Table 6.

Bulk of the petroleum products are used in the transport industry. Next comes the fertiliser industry and then the domestic sector. At the

Table 6—Sector-wise Consumption of Petroleum Products

(million tons of coal replacement)

Sector	1960-61	1970-71	1980-81
1. Transport	13.9	45.8	124.0
2. Iron & Steel	0.4	3.7	14.3
3. Fertiliser	—	7.8	3.4
4. Agriculture	2.1	5.6	12.9
5. Domestic	2.0	4.3	10.2

present time, we are producing a surplus of gasolene, paraffin wax, and bitumen. This is being exported. Also small quantities of kerosene, diesel oil and lubricants are sent to Nepal. During April 1964 to March 1965, the value of this sale totalled to Rs 7·7 crores.

The material balance for petroleum products as envisaged by the Perspective Planning Division of the Planning Commission for the period 1960–75 is presented in Table 7. It would be seen that at the end of the Fourth Five-Year Plan, there would be a surplus of gasolene, kerosene, and high-speed diesel oil but there would be shortage in the light diesel oil and furnace oil. This, however, goes against the findings of the Energy Survey Committee, who have predicted that at the present pattern of demand India is likely to be short of middle distillates and long of light and products. They consider it possible that we would still be importing middle distillates even after 1970/71. At any rate, the crude throughput demand would have increased to 29·25 million tons of which the indigenous crude would be only of the order of 5-6 million tons.

The question that can be discussed is, from the point of view of self-reliance and self-sufficiency is it prudent to base our energy pattern on substantial oil imports particularly when we have adequate sources of coal deposits? Is it advisable to increase our imports on crudes to supply diesel oil for road and rail transport and kerosene for consumption as domestic fuel? It is true that the modern trend is towards the substitution of oil and gas for coal. In the United States, oil and gas accounts for two-thirds of the energy generated and the USSR is also aiming towards the same proportion from early 1970. But it should not be forgotten that until recently the USSR placed greater reliance on coal. In the mid-1950s, oil accounted for only a quarter of the total energy and it is only now that it has increased to half. This in spite of the fact that it had substantial resources of oil and natural gas. It may be that the concentration on the coal and relative neglect on oil and gas has been carried too far during Stalin period and retarded the development of the petrochemical industry. It is not suggested that the coal as a source of energy be developed in India by starving the growth of oil but what is advocated is that the growth of the oil industry should keep pace with the production of indigenous crude. As the Energy Survey Committee has pointed out, at the present rate of

Table 7—Material Balance for Petroleum Products—India 1960-75

(000 tonnes)

Products	1960-61			1965-66			1970-71			1975-76		
	Demand	Production	Export (+) Import (–)	Demand	Production	S (+) D (–)	Demand	Production	S (+) D (–)	Demand	Production	S (+) D (–)
1. Gasolines	940	1050	+190	1665	2314	+649	4185	4780	+595	7000	7300	+300
2. motor spirit plus aviation gas	940	—	80	1065	—	—	1458	—	—	2400	—	—
3. naphtha for fertilisers	—	—	—	100	—	—	1000	—	—	2000	—	—
4. naphtha for petrochemicals	—	—	—	—	—	—	1000	—	—	1600	—	—
5. naphta for blast furnace injection	—	—	—	—	—	—	200	—	—	500	—	—
6. export and for J.P.4	—	—	—	500	—	—	527	—	—	500	—	—
7. Kerosenes	2090	945	–1145	3200	2513	–687	5285	5575	+290	8400	8725	+325
8. kerosene	1900	—	—	2800	—	—	4267	—	—	6400	—	—
9. aviation turbine fuel	190	—	—	400	—	—	618	—	—	1200	—	—
10. export and tractor use	—	—	—	—	—	—	400	—	—	800	—	—
11. High speed diesel	1290	1080	–210	3000	2801	–199	6195	6405	+210	10250	10345	+95
12. railways	60	—	—	500	—	—	1395	—	—	2000	—	—
13. other transport etc.	1230	—	—	2500	—	—	4800	—	—	8250	—	—
14. Light diesel	650	525	–125	760	755	–5	1040	810	– 230	1200	1010	–190
15. Furnace oil	1790	1650	–140	4700	3505	–1195	7535	7410	– 125	11600	11600	—
16. Lubricants	240	22	–218	485	55	– 430	800	806	+ 6	1280	1266	– 14
17. Bitumen	425	410	–15	580	663	+ 83	1000	1100	+ 100	1300	1300	—
18. Others	275	118	–157	450	494	+ 44	700	609	– 91	950	754	–196
19. Total products	7700	5800	+190 –2090	14400	13100	+ 776 –2516	26740	27495	+1201 – 446	41980	42300	+720 –400
20. Refinery fuel and losses	—	350	—	—	900	—	—	1755	—	—	2700	—
21. Crude throughput capacity	—	6150	—	—	14000	—	—	29250	—	—	45000	—

S, Surplus; D, Deficit

development India will depend for something like 30 per cent of the commercial energy supplies on the goodwill and political stability of her oil suppliers. Secondly, she will have to find around 1975/76 about Rs 200 crores to meet these imports alone, almost one-third of the total import capacity.

Problems of the Coal Industry

The problems of the coal utilisation and prospecting of coal have been discussed in the papers submitted to this Working Group by Shri Ghosh, Shri Kar and Shri Roy. Shri Bagchi has also dealt with the investment requirements for the coal utilisation industry and has indicated the foreign exchange component involved.

The coal industry is passing through a crisis. The Planning Commission fixed the target of coal production at 97 million tons for 1965-66 and one time even the higher target of 104 million tons was suggested but it has now come to the conclusion that an output of 70 million tons will suffice the requirements in 1965-66. The slackness in demand for coal was caused by a number of factors including the reduced tempo of industrialisation, improved transport situation causing a run-down in the consuming centres, switch over to oil in place of coal in some industries and the process of dieselisation started by the railways. The indication, however, is that in the economy of coming months, there would be a revival in the demand for coal. The target fixed for the Fourth Five-Year Plan envisages a production of 117 million tons. Of this, 36 million tons represent coking coal, 4 million tons blendable coal and 77 million tons non-coking coal. The total investment envisaged is Rs 340 crores.

To reach the target for coking coal, an additional production of 20 million tons will be necessary. This will mean the private sector will have to increase its production from 17 million tons to 27 million tons and the public sector from 3 million tons to 13 million tons. The requirement of coal for the different sectors is given in Table 8.

Mining

The problem of mining of coal would be discussed in detail in Working Group 9. Suffice it to mention that there is ample scope for utilising indigenous talent and indigenous know-how for increasing the output of coal. It is not necessary to seek foreign assistance in this field though unfortunately there is a trend in the public sector to seek foreign assistance. Further, the import of mining machinery, particularly, sophisticated type of coal cutting machines could be curtailed. The Durgapur Coal Mining

Table 8—Requirement of Coal for Different Sectors

(million tons)

1.	Transport	22·3
2.	Iron & Steel	38·1
3.	Non-ferrous industries	0·2
4.	Electricity	24·4
5.	Fertiliser	1·9
6.	Other industries	30·1
	TOTAL	117·0

Machine Factory has already gone into production and the programme for machanisation of mines should be tied up with the production plans of this factory.

Another problem, which merits consideration is underground gasification. The advantage of underground gasification has been ably dealt with by Shri A. B. Guha on his paper presented to this Session. These briefly are: (a) utilisation of conventionally uneconomical coal seams, (b) production of energy in gaseous form, (c) reduction in human work underground, and (d) maximisation of the coal recovery factor. The recommendations of the Technical Committee appointed by the Government of India need be implemented during the Fourth Plan.

Utilisation of Slack Coal

Nearly 30-40 per cent of the coal produced is below 1″. The price difference between lump and slack coal is negligible, and, therefore, there is no incentive for the consumer to buy slack coal. Most of the slack coal is, therefore, wasted. Even those consumers who requisition lump coal, like the cement industry, the thermal power plants, all crush the coal at their end for using it. There is, therefore, a need to rationalise the distribution of coal and find an outlet for slack coal.

One of the methods of upgrading the slack coal is through the processing of briquetting. This has not found major application in India excepting at Neyveli. Here again, the main reason is the unrealistic price structure fixed for the slack coal. There is an urgent need to revise the coal price structure, particularly for slack coal.

Washeries for Steel Plants

The details of coking coal washery planned for the Third and the Fourth Five-Year Plans are given in Table 9. The present capacity adds up to slightly over 22 million tons of coal per year with a rated capacity of 5,500 tons per hour. Six new washeries with a total capacity of 8·4 million tons are to be set up in the public sector during the Fourth Plan at Ramgarh I, Pundi, Bokaro, Govindpur (Jarangdih), Sudamdih and Central Jharia. In addition, one washery with a capacity of 1·62 million tons is expected to be set up in the private sector. The investment contemplated on coal washery during the Fourth Plan is about Rs 45·25 crores with a foreign exchange component of Rs 7·76 crores. The Central Fuel Research Institute, Jealgora, has hitherto been working out the detailed specification for the various coal washeries. The point which requires consideration is the technical task involved in designing and fabricating the coal washeries with indigenous know-how. Bulk of the coal washing equipment (nearly 90 per cent) comprises material handling equipment for which indigenous know-how and capacity is available. It is only the heavy medium washer which has to be imported. The design of the washer is not an intricate one and attempts should be made to indigenously design it. It is suggested that a committee comprising the representatives of the CSIR laboratories, Iron & Steel Ministry, Durgapur Coal Mining Equipment Corporation and the Heavy Engineering Corporation, Ranchi, be formed to examine in detail the technical task involved in indigenous fabrication of the coal washing equipments.

Upgrading of the coking coal involves fine crushing and it is understood that 2-4 per cent of good quality coking coal run down the drain in

Table 9—List of Coking Coal Washeries to be in Operation by the end of Fourth Five-Year Plan

Washery	Owner or management	Raw coal input m/tons/year	Rated capacity tons/hr	Remarks
1. West Bokaro	TISCO	0.70	135	In operation
2. Jamadoba	do	1.44	300	do
3. Lodna	Turner Morrison	0.40	70	do
4. Dugda I	H.S.L.	2.40	600	do
5. Dugda II	do	2.40	600	Under construction
6. Bhojudih (expanded)	do	2.00	500	In operation
7. Patherdih	do	2.00	500	do
8. Durgapur	do	1.50	360	do
9. Kargali (expanded)	NCDC	2.72	650	do
10. Kathara	do	3.00	800	Under construction
11. Gidi	do	2.84	800	do
12. Sawang	do	0.75	250	do
13. Durgapur	Durgapur Project (W.B. Govt)	1.35	300	do
14. Ramgarh I	NCDC	1.50	—	Proposed in Fourth Plan
15. Pundi	do	1.50	—	do
16. Bokaro	do	0.38(1.50)	—	do
17. Govindpur (Jarangdih)	do	0.30(1.50)	—	do
18. Sudamdih	do	2.16	—	do
19. Central Jharia	do	1.26	—	do
20. Chasnala	IISCO	1.62(2.70)	—	do
		32.22		

the washery. A. B. Guha has estimated this loss to be Rs 6 crores each year. He has suggested that the problem of recovery of this coal from waste be given utmost consideration.

The middlings produced from the washeries are going to pose increasing problems for disposal during the coming years. The planning of future thermal power generation should be based on the use of these middlings and the stations should be located near the washeries.

A problem connected with the burning of middlings is the utilisation of fly ash. Most of the ash is at present being pumped into the river and, therefore, wasted. Whereas, this material is having excellent pozzolanic properties. Pozzolanic cement can be made by blending the coal ash with lime. This could go a long way to augment the present shortage of cement. Since the power stations are mostly in the public sector, consideration be given to installing auxiliary units for utilising the fly ash.

Coal for Steel

The steel plants are going to utilise nearly 38·1 million tons of coal for increasing the production of steel to 13 million tons during the end of the

Fourth Plan. The investment on coke-oven plants envisaged is Rs 44 crores with a foreign exchange component of Rs 14·3 crores. The technical feasibility of indigenously designing the coke-oven plants should be examined by a competent committee comprising the representatives of the design unit of the Steel Ministry, the research laboratories, and the heavy industries. This Committee should also examine in detail the components and spare parts which are envisaged to be imported for maintenance of the existing units during the Fourth Plan.

Domestic Fuel

As has already been pointed out, more than 60 per cent of the total energy is obtained from non-commercial sources. Table 10 gives the energy consumption pattern in the domestic sector for 1960/61. The estimated demand of the energy consumption in the domestic sector for 1970/71 to 1980/81 is given in Table 11. It would be seen that the demand of coal for use as domestic fuel is expected to be only 9·2 million tons.

Table 10—Regional Distribution of Energy Consumption in the Domestic Sector for 1960-61

(million tons of coal replacement)

Region	Coking coal	Non-coking coal	Oil products	Electricity	Fire-wood	Dung cakes	Waste products	Total
1. All India	1.31	1.56	12.90	1.50	95.30	21.60	29.20	163.37
2. Eastern	0.80	0.93	2.66	0.42	21.90	4.54	6.60	37.84
3. Northern	0.23	0.30	1.09	0.21	10.20	3.05	3.20	18.28
4. Central	0.12	0.15	1.82	0.17	17.80	7.34	7.10	34.50
5. Western	0.15	0.16	3.65	0.33	15.70	2.26	4.00	26.25
6. Southern	0.01	0.01	3.14	0.36	25.50	4.19	7.40	40.61
7. Assam	—	0.01	0.52	0.01	4.20	0.22	0.90	5.86

Table 11—Estimated Demand of Energy Consumption in the Domestic Sector for 1970-71 to 1980-81

(million tons of coal replacement)

	1960-61	1970-71	1980-81
COMMERCIAL SOURCES			
1. Oil products	2.0	4.3	10.2
2. Coal	2.8	9.2	28.0
3. Electricity (TWh)	1.5	7.3	17.0
NON-COMMERCIAL SOURCES			
1. Fire-wood	100.0	121.0	131.0
2. Dung cake	54.0	60.0	63.0
3. Waste products	30.7	45.0	62.0

During the Fourth Plan, an investment of Rs 9·5 crores with a foreign exchange component of Rs 2·5 crores is envisaged for the development of low temperature carbonisation plants. The Regional Research Laboratory at Hyderabad has considerable experience on the working of the Lurgi process of low temperature carbonisation. The Central Fuel Research Institute, Jealgora, has experience of working on the externally heated Fuel Research Station process, details of which are given in paper 11.17 and the Regional Research Laboratory, Jorhat, has developed the design and technical know-how for the fluidised carbonisation. It is necessary that these laboratories pool up their resources and in consultation with Planning Commission undertake the design and installation of the proposed low temperature carbonisation plant. They could also consider installing similar units in other areas. The technical problems involved need be discussed in detail.

Recovery of Sulphur as a By-product from Assam Coal

There is also the pressing need to develop processes for recovery of sulphur as a by-product from the high sulphur Assam coals. During the period April 1964 to March 1965 India imported sulphur worth Rs 6 crores and the foreign exchange requirements during the Fourth Plan are estimated at Rs 95 crores out of which Rs 69 crores would be required for the fertiliser plant alone.

The work in progress at Regional Research Laboratory, Jorhat indicates that sulphur could be recovered as a by-product from the flue gases of a thermal power station fired on Assam coals. It should be possible to recover the sulphur in the form of ammonium sulphite or sodium sulphite. The former could be converted by oxidation to ammonium sulphate. The Namrup Fertiliser Plant is basing its supply source on imported sulphur. The Assam Government is planning to have a thermal power station at Marghertia. The possibility of integrating these two projects from the point of view of elimination of import of sulphur should be examined.

Manufacture of Cement as a By-product in Thermal Power Stations

Another aspect of coal utilisation which needs consideration is the manufacture of cement as a by-product in thermal power stations, at present burning low ash coal. For example, the fly ash produced at the Neyveli Thermal Power Station possesses special properties which are not commonly met with the other fly ashes. Usually fly ashes are considered to be pozzolanic material which are non-cementatious themselves. The fly ash from Neyveli exhibits inherent cementatious properties. The material sets rapidly and hardens when mixed with water. The chemical analysis of the fly ash indicates the presence of calcium oxide of the order of 22 per cent all of which is present in the form of calcium silicate and calcium aluminate. X-ray analysis carried out on the ash indicated the presence of calcium silicate. The proportion of calcium oxide to silica and alumina, however, is not the same as is to be found in the normal portland cement. If the coal could be dopped with some excess limestone and then burnt, this should produce fly ash having all the properties of normal portland cement. The ash in Neyveli lignite is about 10 per cent. After blending with limestone for production of cement the ash would increase by another 10 per cent and the calorific value would decrease from 10,000 B.t.u./lb.

to 7,000–8,000 B.t.u./lb. Considering that most of the power stations are being planned to burn middlings having as much as 45 per cent ash, this should not pose any difficulty.

The power capacity envisaged in the Neyveli Thermal Power Station for the Third Plan is 400 mW. and this plant is to be expanded during the Fourth Plan to 600 mW. Production of cement as a by-product from this power station alone would amount to 800–1200 tons per day.

Scientific Tasks

The task involved for developing self-reliance in the energy sector is stupendous but not insurmountable. Some of the technical tasks suggested are as follows:

1. Undertake investigations on substitution of imported materials for turbine generators, transformers and circuit breakers
2. Examine the technical problems involved in the immediate setting up of regional power grids
3. Solve the technical problems in high tension transmission towers
4. Carry out fuel efficiency survey in the existing power stations
5. Examine the possibilities of accelerating the production of indigenous crudes
6. Develop processes for increasing the indigenous production of inkerosene and diesel oil from alternate sources
7. Develop the technical know-how for undertaking design and installation of refineries
8. Develop the design and technical know-how for undertaking the installation of the proposed washeries
9. Examine the technical problems involved in indigenously fabricating the coke-oven plants required during the Fourth Plan
10. Examine the possibilities of accelerating the pace of replacing non-commercial source of energy by primary source in the domestic sector, particularly in the rural areas, and study the technical problems involved in indigenously setting up the low temperature carbonisation plants
11. Undertake developmental work for recovering sulphur as a by-product from the Assam coals
12. Examine the technical problems involved in obtaining cement as a by-product at the Neyveli Thermal Power Station

The discussion of this Working Group would, therefore, be concentrated specifically on these problems.

12. Glass, Ceramics, Enamels, Pottery, Refractories & Mica Industries

Introduction

The main objective of the Conference is to more specifically outline the work to be carried out by the National Laboratories and the industries themselves to attain the maximum self-sufficiency. The programmes of work of the research institutes and the R & D establishments of the industry have to be geared to the problems concerned with import substitution, defence requirements, industrial development and export promotion. Self-sufficiency can be attained only when the entire scientific resources of the country are mobilised for the purpose.

The get-together is aimed at clearly defining essentials and non-essentials in hitherto imported materials, components and technology and to reorientate or expand the research, development and production activities so as to bridge the existing gaps. In the words of Shri Asoka Mehta, Deputy Chairman of the Planning Commission, "Either we extract the utmost out of our production capacity by innovation, imitation and improvisation or we accept decline and decay." Today our economy is unavoidably geared to defence and food, and consequently the foreign exchange normally made available for the private sector's maintenance imports may be cut down from Rs 200 crores every year to Rs 30 or 40 crores. This is a grim indication of the difficult time ahead but the challenge has to be met.

This Working Group is concerned with problems of the glass, enamels, pottery, refractories and mica industries. For ready reference of the participants, the import and export figures relating to materials imported and exported by these industries are given in Appendix 1. The current programme of research at the Central Glass & Ceramic Research Institute—the main National Laboratory dealing with the above subjects, and of the other CSIR laboratories carrying out research work in these fields, is given in Appendix 2. Ever since its establishment in 1950, the CGCRI has laid special emphasis on research work pertaining to substitution of scarce and imported raw materials and production of imported finished articles and Defence items.

Glass Industry

Production. The total production of glass and glassware in India in 1964 amounted to 2.92 lakh tonnes, out of which containerware, flat glass, table and pressedware accounted for 1.35 lakh tons, 0.88 lakh tons and 0.38 lakh tons respectively.

Import of Glass and Glassware

Total import of glass and glassware during 1964-65 amounted to Rs 1.34 crores and consisted mainly of the following items :

(i) Tubes & rods (for scientific apparatus and industrial plants, electric lamps and fluorescent tubes, thermometers and syringes)
(ii) Scientific glassware
(iii) Plate glass
(iv) Thin sheet glass for microscopic slides
(v) Obscured & wired glass
(vi) Toughened glass for automobile wind screens
(vii) Optical and spectacle glass
(viii) Glass shells for electronic valves
(ix) Beads and false pearls
(x) Fibrous glass—wool and textile
(xi) Other items, such as crystal glassware, heat resisting glassware, boiler gauge glasses, glass for sealing metals, special illuminating glassware, fused quartz and 96 per cent silica glass apparatus

Out of the above, items ii, iv, v, vi, ix and x need not be imported as sufficient production capacity for these items now exists in the country.

Lead glass tubing and rods for lamps and valves are not manufactured while tubing for ampoules, vials and fluorescent tubes is in short supply.

Optical glass has been under production at CGCRI since 1961 and need not be imported. For spectacle glass, the Government of India are putting up a plant at Durgapur, scheduled to go into production in 1967.

Manufacture of plate glass has so far not been taken up because the total demand in the country is stated to be too small to put up even one unit.

Manufacture of special illuminating glassware, such as required for airports, lighthouses, mines, etc., is being taken up by one or two factories. Any technical assistance required can be provided by CGCRI.

Compositions for glass-to-metal seals and parts of electronic valves can be developed at CGCRI. It is learnt that development of fused silica tubes has been taken up at NPL and of 96 per cent silica glass at RRL, Hyderabad.

Materials Imported by the Glass Industry

Raw Materials

(a) *Decolourising agents*, such as selenium, arsenic, saltpetre and cobalt oxide. These are used chiefly by the containerware, holloware and pressedware sections of the industry. In the case of bottles and containers, the functional properties are more important than the colourlessness and it is, therefore, not essential to use imported decolourisers for these articles. In other sections, the quantity required can be reduced to the minimum by using washed sand and better garade raw materials. Sufficient work on the subject has already been done at CGCRI and it has been established that majority of the factories use unnecessarily excessive quantity of arsenic and selenium. The Institute has several times invited attention of the industry to this aspect.

(b) *Colouring materials*, such as cobalt oxide for blue glass, selenium and cadmium sulphide for red glass, sulphur for amber glass and cryolite or fluorspar for opal glass.

Instead of using cobalt blue glass for certain pharmaceutical lotions and poisons, glass of another suitable colour can be used. The matter can be examined at CGCRI.

Ruby glass is used mainly for making signals, electric bulbs and bangles. The use of imported selenium can be definitely avoided in bangles and bulbs by adopting selenium-free compositions developed at CGCRI. The work of finding substitute for selenium was taken up at the Institute at the explicit request of the bangle industry, the largest consumer of selenium, which had then appeared to be very keen to make use of the results. After extensive trials of the Institute's process in the bangle factories at Firozabad, the manufacturers expressed their satisfaction with the results which were released to them free of charge. But when the question of banning the import of selenium was taken up, the industry started finding faults with the substitute. Due to this resistance and because the import of selenium was not curtailed by the Govt of U.P., the results of research remained unutilised. When the matter was pursued further by the Director of the Institute, the Secretary to Government of U.P. agreed that Essentiality Certificates should not have been issued for the import of selenium.

For carbon-sulphur amber glasses, sulphur may be substituted by sulphates of sodium, calcium or barium. Alternatively, iron-manganese amber can be used.

For opal glass compositions, indigenous fluorspar, beneficiated by the process developed at NML, or indigenous sodium silicofluoride can be used. These fluorides may also be employed as melting accelerators.

Glass-house Refractories

The main refractories imported by the glass industry are the zirconia-alumina electrocast tank blocks and the feeder refractories.

The only indigenous alternative to electrocast material is Khasi sillimanite which is in short supply. Ways and means may be discussed to make more of this material available to the Indian glass industry.

Bonded sillimanite, kyanite or clay tank blocks manufactured indigenously still remain of unsatisfactory quality, mainly because no refractory plant has specialised in these items. Efforts should be made to induce one or two manufacturers to take up the production of vacuumcast blocks which should be fired thoroughly at a temperature higher than that of use.

The question of supply of good feeder refractories is already being examined at CGCRI.

Shortage of good glass-house refractories may become a bottleneck in the development of glass industry and requires careful planning.

Spare Parts and other Materials

(a) Spare parts to the tune of about Rs 24 lakhs are imported annually by the automatic sector of the industry. Recently, the industry and DGTD have gone into the question of indigenous production of these parts and it is understood that through mutual cooperation of glass factories, at least 90 per cent of the parts may now be manufactured locally. For remaining parts, cooperation of CMERI can be sought.

(b) Other imported items are:

- (i) Lubricants for glass forming machines and moulds
- (ii) Interlayer of polyvinyl butyral ('Vinal') used in the manufacture of laminated safety glass
- (iii) Asbestos for rollers of sheet glass drawing machines
- (iv) Components of annealing lehr
- (v) Certain control instruments

Development of Glass Industry, Exports, etc.

The role of glass as packaging material and tableware will assume further importance on account of shortage of tin and other metals. The industry has already started receiving enquiries for large containers hitherto always fabricated from metal. Since the automatic glass forming machines are all imported at present, efforts should be made to produce in the country simple glass forming machines, motorised presses and feeders. Production of glassware may also be increased by employing more semi-automatic machines which are available in the country. The selling price of tableware, especially pressed tumblers, must be brought down through increased production so as to bring them within reach of the masses.

Due to very high cost of glass raw materials, especially soda ash and fuel oil, the cost of production of glass is too high to compete in the international market. Nevertheless, export of glass and glassware increased from Rs 33 lakhs in 1963-64 to Rs 67 lakhs in 1964-65, mainly due to lesser internal demand for flat glass and its higher export to South Viet Nam and Malaysia. Containerware and scientific glassware were mostly exported to Pakistan and small quantities to Afghanistan and Ceylon.

Enamel Industry

Production. During the last five years the total annual turnover of the enamel industry has increased from Rs 1.5 crores to Rs 3.5 crores and it has already made a small beginning towards exporting its products, mainly to the West Asian countries.

Import of Enamels and Enamelware

The main items of import consisted of enamel stains, glass enamels, cast iron enamel frits and finished enamelled articles like glass-lined reaction vessels and diaphragm type enamelled acid pump valves for the chemical industries.

Enamel stains are already being produced at CGCRI under Production Scheme. These stains, in combination with the base enamel frits, can be used on glass. Suitable base enamel frits are under development.

Enamel frits for cast iron bath tubs have already been developed and produced at CGCRI. These frits have been supplied in quantities amounting to a few tons to a leading consumer, who had earlier been using imported enamels for the purpose, with satisfactory results.

Diaphragm type valves of all varieties, including enamelled and rubber-lined, are imported to the tune of about Rs 25 lakhs per annum. The Institute has developed enamel compositions of suitable corrosion resistance properties as well as process for applying these on indigenous cast iron valve bodies and has taken up production of these enamels to save valuable foreign exchange.

Considerable work on glass-lining of reaction vessels has been done at RRL, Hyderabad. It is also learnt that a firm in Maharashtra has recently started making glass-lined vessels.

Materials Imported by the Enamel Industry

Raw Materials

Aluminium hydroxide, barium carbonate, bentonite, enamelling clay and fluorspar—These materials are now manufactured in the country and there is no reason why the indigenous materials should not be used. Fluorspar is now produced in quite pure grades (99 per cent) by a public sector undertaking in Gujarat from low-grade Indian Fluorspar. Barium carbonate is also manufactured in Rajasthan and Andhra Pradesh. Bentonite and enamelling clays are available in the country.

Antimony oxide has been in use as an opacifier but is not considered essential particularly when titania opacified white enamels have been already in use in the country. The CGCRI has also developed white enamels, mainly of the boron-free type, in which antimony oxide is not required; the results are to be published shortly. A further point against the use of this material in enamels is that the Defence specifications forbid its use in most of the Defence items.

Borax and boric acid—Although these materials are now being manufactured in the country, the raw materials have still to be imported and foreign exchange equivalent to Rs 250 to 300 is stated to be required for every ton of borax produced. The CGCRI has developed enamel compositions of all types which do not require the use of any boron compounds and extended trials under working conditions in a number of factories have shown that these enamels can be used in place of the conventional borax type enamels. The patent was assigned by NRDC to one of the big enamel manufacturers but for some inexplicable reasons no steps have been taken to produce these enamels.

Cobalt oxide and nickel oxide—These materials are being used for ground coat enamels. However, the material chiefly responsible for adherence being cobalt oxide, the use of nickel oxide can be safely dispensed with if necessary with a slight increase in cobalt oxide. Since the proportion of cobalt oxide in ground coat enamels seldom exceeds 0.5 per cent and the total requirement for this purpose is only a few tons per annum, the import of this material for ground coat enamels could be continued.

The CGCRI has developed ground coat enamels without cobalt oxide. In these compositions nickel oxide has to be used in the batch but can be dispensed with if nickel dipping is used in the metal pretreatment process. The results are being published for use of the industry.

The main consumption of cobalt oxide, however, is in blue colouring oxides or blue coloured enamels which can be replaced by indigenous green colouring materials, viz. chromium oxide.

Cryolite is mostly used in white and semi-opaque enamels. Its use is not essential and it can be substituted by indigenous sodium silico-fluoride with suitable adjustments.

Potassium and sodium silico-fluorides—The sodium compound is already being produced indigenously. The potassium compound is not essential as the small proportion of potassium oxide contributed by the compound can be easily obtained from other sources, e.g. potassium nitrate.

Tin oxide has been in use at some factories for the characteristic opacity and finish of enamel. This, however, is not an essential constituent as opacity of a high order can be obtained by using indigenous titania, which is also much cheaper than tin oxide. The boronfree white enamels developed at CGCRI have utilised indigenous titania and the colour obtained is a good white one. The borax compositions, on the other hand, give a characteristic yellowish discolouration with titania.

It is learnt that titania opacified enamel frits have also been developed at RRL, Hyderabad on pilot plant scale.

Zirconium oxide can be easily replaced by indigenous zircon sand with suitable adjustment of silica content of the composition.

Enamel stains are imported in considerable quantities for imparting a variety of colours to the enamel finish, which are not essential for the functional properties of the enamel. In any case, a limited range of enamel stains can still be produced from indigenous colouring materials like chromium oxide, iron oxide etc. There is also a good scope of developing enamels stains and ceramic colours from indigenous rare earth oxides.

The CGCRI has been producing enamel stains and ceramic colours on commercial basis and has been supplying these to the industry for the last about five years.

Sheet Iron and other Materials

(a) *Enamelling quality sheet iron*—The industry consumes nearly Rs 2 crore worth of iron sheets per year and a considerable proportion of this is imported for reasons of shortage and lack of requisite quality of the indigenous product. However, as indigenous production has been catching up both in quality and quantity, it may not be necessary to import sheet iron except for very special requirements. The steel industry should be asked to make low carbon steel suitable for enamelling.

The CGCRI carried out studies on some indigenous sheet irons, like certain grades of Tata and Rourkella sheets, which were found to be suitable for the conventional enamelling process as well as for the process of one coat white enamels directly applied on steel, the latter being with suitable adjustments in the pretreatment of metal. However, these sheets are not produced in sufficient quantities at present.

(b) *Silicon carbide* refractories for enamel furnaces, imported by some parties, are not essential and can be replaced by indigenous refractories. The Development Wing has suggested the use of fused alumina refractories which are expected to be produced in the country shortly.

Development of Enamel Industry, Export Promotion, etc.

The Indian enamel industry contributes to the national economy of the country by providing cheap utensils to the low income groups and meeting hospital, defence and industrial needs of the country for a wide variety of enamelware. The total production of enamelware in the country has more than doubled during the last five years.

The total exports of enamelware increased from Rs 0.44 lakh in 1963-64 to Rs 1.72 lakhs in 1964-65.

The CGCRI has organised testing facilities for enamel frits and enamelware according to different specifications. Some of these specifications have been laid down by ISI for pre-shipment testing of enamelware meant for export and the Institute has started testing enamelware for this purpose.

Use of Enamels in Agriculture

A variety of elements, like manganese, zinc, iron, copper, cobalt and boron, are useful when used in traces to enrich the soil for agricultural purposes. In some countries these are being produced as 'fritted trace elements' (F.T.E.) and the frits so prepared are mixed with fertilisers before use.

The Institute can take up work on the development of such products in collaboration with Government or private institutions who can evaluate their suitability for agricultural purposes.

Pottery Industry

The pottery industry produces a wide range of articles, viz. stoneware pipes and jars, whitewares, glazed tiles, sanitaryware, insulators, chemical porcelain, art pottery, etc. The total production of these articles in India in 1964 amounted to 1.29 lakh tonnes, out of which stoneware pipes and jars were about 80 thousand tonnes, sanitaryware about 11 thousand tonnes, whiteware 23 thousand tonnes, glazed tiles 5.5 thousand tonnes and insulators about 10 thousand tonnes.

Import of Pottery and Porcelain

Total import of pottery and porcelain insulators in 1964-65 amounted to Rs 1.65 crores, out of which insulators alone accounted for Rs 1.62, crores. Crockery and household articles worth Rs 2.3 lakhs were imported.

Several new units for the manufacture of high tension insulators have been set up in the country during the last two years and there may now be no necessity to import this item.

The production of steatite and alumina porcelain has not yet been taken up on a commercial scale. Raw materials for their manufacture are available within the country and compositions have also been worked out at CGCRI. The material and design of dies and the technique of pressure forming are the main problems in taking up large-scale production of steatites.

Recently, the production of fine dinnerware has been stepped up and this item now should not be imported.

Materials Imported by the Pottery Industry

Ball clays and china clays were imported to the tune of Rs 23 lakhs during the last year.

The CGCRI investigated the problem of ball clays and it was found that several plastic clays available in the country, especially clays of Bikaner, Elloor and Padapakkera, could be used as suitable substitutes. Some of these plastic clays need grading and washing before regular supply of uniform quality can be assured.

The CGCRI has also done work on the beneficiation of clays and other ceramic raw materials. This will result in utilisation of inferior china clays and elimination of import of these clays. A pilot plant for bleaching of clays is being set up at the Institute. The process has also been leased out to a china clay producer in West Bengal.

Work has also been carried out to show that good quality bentonites are available within the country and that there is no necessity to import them.

The work on survey and evaluation of indigenous clay deposits and other raw materials for ceramic and refractory industries is being intensified at CGCRI but the progress has often suffered for want of adequate facilities for evaluating raw materials in bulk quantities. *A Unit for the Industrial Evaluation of Ceramic Raw Materials* was included in the Third Plan of the Institute and should be sanctioned very early. The Geological Survey of India should also be requested to intensify field work on ceramic raw materials.

In addition to studying the properties of individual clays and their fractions, blending of local plastic clays and china clays and developing suitable body compositions has been suggested.

Opacifiers—In India imported tin oxide has so far been the most common opacifier used in glazes. Due to its high cost, some factories have switched over to zirconium compounds which are also imported.

The work done at CGCRI has shown that indigenous zircon sands can be used as the base material for making opacifiers. Utilisation of this material will eliminate the import of tin oxide and zircon.

M/s F.X.P. Minerals and M/s Travancore Minerals—the suppliers, may be requested to standardise the quality of their zircon sand for supply to the ceramic industry.

Lead Oxide and Borax for Glazes

Lead oxide and borax, although manufactured in the country, are made from imported raw materials. The CGCRI has been studying the question of replacing these materials and has developed lead-boronfree glazes. The performance report from a wall tile factory has been satisfactory. The glazed tile samples showed extremely high craze resistance. Factory trials on dinnerware showed slight yellowish discoloration only at the edge. Adoption of these glazes will eliminate the use of lead oxide and borax.

Development of Pottery Industry, Export Promotion, etc.

The pottery industry has an important role to play in conserving metals used for utensils and tableware. The cost of production and the selling price must, however, be reduced very substantially to bring ordinary cups and saucers, plates, bowls, etc. within reach of the common man.

The exports made by the industry so far have been nominal. With increased production of sanitaryware and insulators, there may be a good scope to export these items. It is learnt that a delegation from the industry will be soon visiting West Asian & East African countries to explore markets for Indian sanitaryware, tiles, dinnerware and other pottery articles.

Refractories Industry

The refractories industry in India has developed considerably during the last ten years mainly as a result of setting up of steel plants and other consuming industries. Total production in 1964 was about 7 lakh tonnes, out of which firebricks, silica bricks and basic bricks constituted 4.24 lakh tonnes, 0.47 lakh tonnes and 0.61 lakh tonnes respectively.

Import of Refractories

Last year, refractory bricks and other refractory construction materials were imported to the tune of Rs 2.44 crores, out of which imports from USSR alone were worth Rs 2.02 crores.

Refractories which are not produced in the country in sufficient quantity or in adequate quality are the high alumina (Al_2O_3 above 70 per cent) refractories, carbon refractories, silicon carbide refractories, electro-cast refractories, castables and high alumina cement of Cement Fondu type. All other refractories are produced in the country, although the quality of some casting pit refractories does not satisfy the consumers' requirement.

The quality of most of the indigenous fireclay, silica and basic products compares well with similar foreign products. The import of these refractories is probably due to the insistence on the part of the foreign collaborators to use refractories produced in their countries, with which they are familiar, and also due to reported time lag between demand and availability. Silica bricks, required mostly for coke ovens, have nearly 600 different shapes which require time to produce.

It is reported by the Durgapur Steel Plant that they have completely eliminated the import of refractories.

The Tata Iron & Steel Co. has reported that they have progressively cut down the imports from Rs 29.2 lakhs in 1962 to Rs 2.6 lakhs in 1965.

To eliminate imports, CGCRI took up the development of high alumina (75 to 95 per cent Al_2O_3) refractories, casting pit refractories, castables and monolithic linings for furnaces, and oxide refractories containing up to 98 per cent Al_2O_3.

High alumina refractories containing up to 80 per cent Al_2O_3 were made from bauxite while up to 95 per cent Al_2O_3 bricks were produced from technical alumina. The properties of bricks fired to 1600°C. were found to be comparable with those of imported bricks. Casting pit refractories of good quality have also been produced.

For actual trials in steel plants it is necessary to produce the refractories developed in the Institute in sizeable quantities, for which facilities should be available. As already mentioned, a Unit for Industrial Evaluation of Materials at CGCRI is absolutely essential for this type of work.

High alumina cement has been developed at NML and at CGCRI. Its indigenous production will eliminate the need for importing this material.

NML had developed the process of making graphite crucibles which are still being imported in large quantities. Indigenous production of these crucibles should be expedited.

Work on the synthesis of silicon carbide, required by the abrasive and refractory industries, is in progress at RRL, Hyderabad. An experimental furnace with a yield of 60 kg. of grains per day is in operation in the laboratory and quality of the products has been found to be satisfactory. A pilot plant is proposed to be set up.

Standard Pyrometric Cones identical in performance with the imported Orton cones, are being produced regularly at RRL, Hyderabad. At present, about 2-3 lakh cones a year are being supplied to the industry.

It has been suggested that indigenous pyrometric cones should be adopted by ISI for testing of refractories and refractory products.

It is reported that shortage of blast furnace refractories may occur in the country because good high-alumina clays are not readily available. Indian Bureau of Mines and GSI may be requested to take up field work for locating more sources of this type of clay.

Field work is also necessary to locate better grade magnesite and reasonably low iron refractory grade chromite. The type of chrome being used for refractory purposes is of metallurgical grade and may not be available to the refractory industry in future.

As already mentioned, evaluation of clays and other materials like kyanite, bauxite, chrome ores, magnesite, etc. should be taken up in bulk quantities, for which the proposed Unit for Industrial Evaluation, of Ceramic Materials should be put up very early.

Other Items of Import

Special steel required for moulds of presses are at present imported. Quantitatively, the requirement is small but the items involved are critical ones for quality of the products. The problem of manufacturing these in the country requires to be looked into.

Some of the refractory manufacturers need certain balancing equipment to take up some of the specialised lines to eliminate imports of these items. It would be cheaper to give facilities to the indigenous manufacturers to import the balancing machinery than to import specialised refractories continuously year after year.

Export Promotion

Work on the beneficiation of low-grade kyanites is in progress at NML and CGCRI. This will help in earning more foreign exchange.

It is suggested that more of calcined kyanite or refractory products made from kyanite or sillimanite should be exported rather than raw kyanite or sillimanite. This will earn the country more foreign exchange.

Mica Industry

India is the chief mica producing country and meets about 80 per cent of the world requirements, particularly of quality mica. For India, mica is mainly an exportable commodity, earning a foreign exchange of about Rs 10 crores per annum. Internal consumption of mica and mica products is very little and no precise information regarding the requirements of the country is available.

Use of Mica in Defence

The main consumption of mica is in the electrical and electronic industries and in view of its vital role in some of the essential defence and communication equipment, in most of the consuming countries mica is considered to be a strategic material.

For some of the defence equipment, very high quality mica is required and as even in the best mines the production of such material is very little as compared to the total saleable mica, sometime back the CGCRI drew attention of the Government to examine the desirability of restricting the export of very good quality mica which might be required for our own defence equipment. In consultation with the GSI, Indian Bureau of Mines and Bharat Electronics it was, however, decided by the Government that there was no necessity of imposing any restrictions on export at least for another 10 years. It is not known whether in view of the present emergency the situation has changed.

The Bharat Electronics has already started the production of some of the electronic valves and telecommunication equipment. To attain self-sufficiency it would be necessary to start the production of many other items. Not only sheet mica but a host of mica products, e.g. fabricated mica, silver/mica capacitors, mica-filled mouldings and laminates, mica tapes, glass-bonded mica, etc. are used in some form or the other in electronic equipment. It would, therefore, be desirable to make an evaluation study of what is being made or could be made to meet the defence requirements. No research or development work can be taken up unless details of the requirements are made available.

Ground mica (made out of scrap or mica waste) has also a number of important wartime uses even though it is not considered a strategic material. In some countries, particularly the USA, dry ground mica is used for surface coating of landing mats. Wet ground mica is used in water-proofing tent canvas. No information is available regarding the consumption of mica powder for such uses in the country.

Import Substitution

It might be possible to use mica or mica products as substitute for some of the imported electrical or thermal insulating materials provided their fields of application and service requirements are made available. For example, materials like 'prespan', 'leatheroid', etc. could possibly be replaced by built-up mica (i.e. micanite). Again, asbestos boards, 'limpet spray asbestos', 85 % magnesia, asbestos tapes, etc. could possibly be substituted, at least partly, by some of the products developed out of mica. In the field of paints some of the imported pigments could be partly replaced by wet ground mica for whose manufacture a process was developed at CGCRI. Substitution of a considerable portion of alumina powder or paste in paints by mica powder would no doubt release a substantial amount of aluminium for purposes where imported non-ferrous metals are at present being used. It would, however, be necessary to first start the production of wet ground mica for which the technical know-how has already been worked out at CGCRI. The NRDC had assigned the patent to two Indian parties who, despite the process being one held secret in other countries, have not taken steps for its production.

Another possibility of import substitution is to use lepedolite as a source of lithium chemicals which are at present being imported. The CGCRI has already taken up this problem for investigation.

Export Promotion

Mica being mainly an exportable commodity, all priority is to be given to boost up its export. But mica is an engineering material and not a consumer good and there may, therefore, be not much of a scope to increase the volume of export unless some new uses are developed. But it appears reasonable to expect an increase in the value of export by (a) making sustained efforts in finding ways and means to export manufactured mica and mica products instead of crude unprocessed mica in the form of sheet or scrap; (b) by efficient utilisation of mica, particularly of the so-called inferior varieties, by introducing "objective classification" in the export market. The CGCRI has been working on this subject for quite some time and has developed a handy apparatus for evaluating the electrical quality of mica. The practical feasibility and economics of introducing objective classification in the pre-shipment inspection scheme for mica is now being explored.

Fabrication of mica has been started in India fairly recently and about half a dozen plants have already gone into production. Many more could go in this line provided some of the difficulties, e.g. non-availability or precision dies and punches for mica cutting and stamping, resistance offered by the foreign countries in purchasing fabricated mica instead of raw mica, could be tackled with success. The difficulties are not unsurmountable and efforts should be made to design and fabricate special dies and start producing more of the finished products like condensers, micanite, mica powder, glass-bonded mica, etc. The technical know-how or the finance required is not beyond Indian talents or resources. What is most important is to develop proper market for the products. Both extensive and intensive market surveys are, therefore, required to be made in the important consuming countries with a view to ascertaining the competitive position of mica in the field of insulating materials and to pin point the fields of application where mica can preferably be used provided fabricated mica is made available at prices competitive with other materials. As an insulating and dielectric material, mica commends high reliability, inherent stability, dependable performance, long life and resistance to high temperature, all of which warrant its greater use in the ever expanding field of electrical and electronic industry. But there is no denying the fact that on technical or economic ground mica has been losing ground, at least in some of its uses, to other materials and the market survey has to pinpoint the factors responsible for this shift. The only way to make mica components competitive with materials manufactured on a mass scale is to encourage fabrication of mica in India where both the material and labour are cheap. It is true that so long as raw material will be easily available at a comparatively lower price, the consuming countries will naturally resist the fabrication or manufacture of mica products in the producing country. In fact, this is one of the reasons why the fabricators and manufacturers of micanite or mica powder seem to find it difficult to create a proper market for their products. Some of the steps recently taken by the Government in fixing the floor price have no doubt stabilised the industry to some extent and also resulted in an increase of foreign exchange earning. If required and considered judicious, pressure might have to be exerted on the importers to purchase fabricated mica and mica products by restricting the export of raw mica. The Working Group on mica set up by the Planning Commission has also recommended to expedite mica fabrication in the country and to provide necessary facilities for making mica dies.

Lack of technical information on mica, particularly of the different commercial qualities, has frequently been cited by the foreign consumers as one of the reasons to prefer synthetics and other substitutes for which the required information is readily available. It has, therefore, been recommended that steps are to be taken for the compilation of the required technical information on mica in a suitable form and disseminating it to the producers, exporters, importers and particularly the designers and end-users. The CGCRI has already taken up the work. It has also undertaken a long range programme to make a comprehensive study of the properties of different varieties of mica.

Use of Mica in Agriculture

Muscovite mica contains 12 to 13 per cent potash and an economic and efficient utilisation of mica scrap or micaceous materials for the recovery of potash for use as a plant food would no doubt serve one of the prime needs of our agriculture. Besides, the development of such a process would revolutionise the prospects of mica mining in the country, opening up a very useful utilisation of the reserves of mica waste. In the context of present emphasis on food production, the CGCRI has recently taken up this problem for study.

APPENDIX I

Import and Export Figures

IMPORTS (1964-65)

(Taken from DCIS Monthly Statistics of the Foreign Trade of India)

Article code	*Articles and countries of origin*	*Value* (in lakh Rs)
66203	**Refractory bricks & other refractory construction materials**	
	(a) Fireclay bricks & shapes (USSR 17.55, USA 1.60, Belgium 1.75, UK 0.94)	21.37
	(b) Firebricks & shapes NES (USSR 21.71, W. Germany 5.81, UK 1.26, USA 2.68, Belgium 3.93, France 0.90)	36.68
	(c) Silica bricks & shapes (USSR 38.96, UK 0.42)	39.38
	(d) Magnesite bricks & shapes (Austria 4.79, W. Germany 2.67)	7.47
	(e) Silicon carbide bricks & shapes (Japan 0.79, UK 0.28, Czech 0.19)	1.21
	(f) High temp. cement & mortar (USA 3.37, W. Germany 0.43, Netherlands 0.39, Japan 0.43, UK 0.29)	5.18
	(g) Insulating bricks (Denmark 0.16, USA 0.09)	0.32

	(h) Graphite bricks & shapes (Japan 0.09)	0.13
	(i) Others (USSR 123.91, W. Germany 2.55, USA 2.47)	132.70
		244.44
66307	**Refractory products, except refractory construction materials**	
	(a) Graphite crucibles	29.51
	(b) Other kinds	19.40
		48.91
	Glass & Glassware	
66401	**Glass in the mass**	
	(i) Tubes & rods (UK 9.12, Netherlands 4.65, Hungary 3.66, Japan 2.45, Italy 1.79, W. Germany 1.38)	23.72
	(ii) Others (UK 0.61, Netherlands 0.34)	1.44
66402	**Optical & spectacle glass unworked**	
	(Japan 3.22, W. Germany 1.23, UK 1.68)	6.55
66403–5	**Flat glass**	
	(i) Sheet glass unworked	
	1. Window glass (Belgium 0.64)	1.07
	2. Other sheet glass(USSR 3.47, W. Germany 0.73, Belgium 0.65)	4.94
	(ii) Plate glass unworked (UK 7.56, Belgium 4.38)	12.60
	(iii) Rolled obscured or wired glass (W. Germany 0.96, Poland 0.64, Czech 0.59)	2.21
66407	**Laminated & other safety glass**	
	(i) Safety glass sheet	0.08
	(ii) Toughened glass sheet (USA 5.46)	5.48
	(iii) Others	0.07
66408	**Sheet & plate glass, tinned, silvered or coated** (Belgium 2.06, UK 0.29)	2.55
66409	**Glass NES**	
	(i) Bulbs for electric lamps & electronic valves (UK 1.54)	1.72
	(ii) Others (UK 0.51, W. Germany 0.44)	1.15
665	**Glassware**	
	(i) Tableware, etc.	1.65
	(ii) Bottles, flasks, etc.	0.25
	(iii) Beads & false pearls (Austria 2.37, Czech. 1.49)	4.18
	(iv) Fibrous glass, loose wool (Sweden 1.40, UK 1.21, USA 0.69)	3.92
	(v) Fibrous glass, textile (W. Germany 1.39)	1.98
	(vi) Glass mirrors (UK 0.22)	0.30
	(vii) Scientific glassware (UK 12.90, USA 6.85, W. Germany 3.52, E. Germany 1.72, Japan 1.33)	28.63
	(viii) Others NES (UK 7.59, USA 2.43, W. Germany 1.59, Japan 1.83, Netherlands 1.95)	18.44

812040402	Glass globe, funnel & chimney	0.23
812040409	Other illuminating glassware (UK 0.41, France 0.18)	0.77
861010700	Optical glass blanks (UK 3.71, Japan 2.52, USA 1.56, W. Germany 1.42)	9.80
	Total glass & glassware	**133.73**
721190591–9	**Porcelain insulators**	
	(a) Insulators above 11 kV. (Japan 52.61, W. Germany 10.87, Bulgaria 2.50)	70.27
	(b) Insulators up to 11 kV. (Japan 0.16, UK 0.12, Canada 0.10)	0.43
	(c) Insulator shackle, spacing insulators, cleats (Sweden 0.24)	0.52
	(d) Insulators & bushing for transformers (UK 2.80, W. Germany 0.99, Switzerland 0.92)	5.57
	(e) Insulators for telegraph & telephone (USA 0.35)	0.43
	(f) Porcelain insulators NES (Japan 58.92, UK 10.89, USA 1.30, France 5.42, Italy 2.40, Canada 2.06)	84.69
	Total porcelain insulators	**161.91**
	POTTERY	
66601	Table, household & art articles of baked clay or ordinary stoneware	0.03
66602	do of fine earthenware (UK 0.18)	0.21
66603	do of chinaware or porcelain (UK 0.64, W. Germany 0.52, Switzerland 0.65)	2.11
812020100	Earthen sanitaryware (UK 0.35)	0.36
		2.71
	Bricks, tiles, pipes, etc.	
66201	Bricks, tiles, pipes & other products of brick, earth or baked clay (UK 0.44, USA 0.36)	0.90
66202	Wall tiles, floor tiles, pipes & other clay construction materials	0.09
		0.99
27204	**Clay including chamottee & china earths**	
	(a) Ball clay (UK 5.60, Japan 2.17, W. Germany 0·68)	8.47
	(b) Bentonite (USA 3.13, UK 0.16)	3.30
	(c) Earth clay (W. Germany 2.02, USA, 0.11)	2.13
	(d) Fire clay (USA 1.10, UK 0.07)	1.17
	(e) China clay (UK 7.82, Czech. 5.25, W. Germany 0.55)	14.33
	(f) Others (UK 0.62, W. Germany 0.37)	1.38
		30.78
66304	Manufactures of mica (UK 0.36, USA 0.21)	0.61

EXPORTS

(Taken from DCIS Monthly Statistics of the Foreign Trade of India)

Article code	*Article*	*Value* (in lakh Rs)	
		1963-64	1964-65
662	**Clay and refractory construction materials**		
66201	Bricks, tiles, pipes & other products of brick, earth or baked clay	19.26	7.42
66202	Wall tiles, floor tiles, pipes, etc.	0.55	0.05
66203	Refractory bricks & other refractory construction materials	3.40	6.72
		23.21	**14.19**

	GLASS & GLASSWARE		
664	(i) Window glass & other sheet glass	0.26	20.88
	(ii) Rolled, obscured or wired glass, laminated & other safety glass, glass tubes & rods, etc.	1.42	4.39
665	(i) Bottles, phials, flasks & containers	20.28	21.91
	(ii) Tableware, beads & false pearls, scientific glassware, mirrors & glass NES	7.04	13.54
	(iii) Glass bangles	1.12	3.01
81204	Glass globe, funnel & chimney and other illuminating glassware	2.95	3.40
		33.07	**67.13**
	POTTERY		
666	Table, household and art articles of clay, stoneware, earthenware, percelain and others	1.20	0.61
812020100	Earthen sanitaryware	0.68	0.47
721190501 & 9	Porcelain insulators etc.	0.18	0.27
		2.06	**1.35**
69913	**Enamelled hollow ware**		
	Basins, mugs, dishes & other hollow ware	0.44	1.72
	MICA		
66304	Mnfrs of mica cut, punched, wrappers, micanite, etc.	23.15	49.99
27213	Mica uncut or unmanufactured in sheet or blocks, scrap mica unground or ground	919.64	986.43
		942.79	**1036.42**

APPENDIX 2

Projectwise Research, Development & Production Programme of CGCRI & other Institutes for 1965-66

A. DEFENCE ORIENTED PROJECTS

1. Production of optical glass slabs & blanks

Optical glass—a strategic Defence material used in making field binoculars, telescopes, gunsights, etc. and a host of other optical instruments, such as theodolites, levels, microscopes, cameras, etc., has been under production at the Institute since 1961 and almost the entire requirement of the Defence and Civilian consumers is being met from the Institute's plant. In view of the rapid increase in requirements, production of optical glass has been stepped up. Newer varieties are also being developed as and when required.

2. Production of large glass prisms for tank periscopes

The production of special periscope prisms was taken up a few months ago and is being stepped up to meet the entire requirement of Defence.

3. Production of special glass filters

Glasses having special absorption characteristics for use in locating and firing devices, night patrolling, etc. have been developed for the Instrument Research & Development Establishment, Ministry of Defence. The performance report in respect of some filters has been satisfactory. Further work is in progress.

4. Hydrothermal synthesis of quartz

The technique of growing quartz monocrystals suitable for oscillators, filters and resonators has been developed. Development work is awaiting procurement of suitable steel for making high-pressure autoclaves.

5. High temperature protective enamel for aero-engines

Special enamel compositions for exhaust systems of jet engines to protect them against high temperature corrosion, oxidation and chemical action of exhaust gases have been developed. The performance report has been satisfactory and enamels are under production for supply to the Gas Turbine Research Establishment, Bangalore.

6. Enamel coatings for heat resistant steels (compressor stator) and aluminium alloys (actuator shroud and compressor rotors) parts of aircrafts

Work on these items has just been taken up at the instance of Gas Turbine Research Establishment, Bangalore.

B. PROJECTS OF POTENTIAL DEFENCE USE

1. Crystallisation of glasses in the system BaO-TiO_2-SiO_2

Barium titanate crystals have been obtained on crystallisation of glasses. Main advantage of the process is that even complicated shapes can be fabricated easily. Further work is in progress to obtain high dielectric materials on crystallisation of glasses.

2. Magnesium aluminate

Magnesium aluminate has been sintered. The possibility of obtaining materials with sharp cut-off and transmission in infra-red is being studied.

3. Crystallisation of glasses in the system Li_2O-SiO_2

A method for determining the correct amount of nucleant to be used for catalysed crystallisation of glasses has been established. This can be used for evolving high strength glasses for nose-cones, etc.

4. Aluminium titanate — Tiellite

Tiellite, a synthetic product of alumina and titania, has been developed. It can be used as thermistors, turbine blades, gas burner tips, etc.

C. IMPORT SUBSTITUTION/ELIMINATION

1. Survey, evaluation and beneficiation of ceramic raw materials

This is a long range activity and is linked with the programme of the Geological Survey of India which looks to field work of collecting samples and information regarding extent of deposit, means of transport, etc., and the Institute examines the samples for their suitability.

Survey and evaluation work of indigenous clay deposits is being intensified. In order to locate good plastic clays for use in the pottery industry, so as to avoid import of ball clays, work on evaluation of plastic clays available in different parts of the country was taken up and results were brought to the notice of the industry. Further work is in progress.

It was also shown that indigenous china clays can be improved by adopting proper methods of washing. Some clays, otherwise suitable for the ceramic industry, suffer from bad colour. A method has now been worked out to remove one of the two major colouring ingredients in clays and by its adoption at least 50 per cent or more of such clays can be brought to the standard quality.

In view of increasing importance and demand of refractories, particularly the basic type for the steel plants which are largely imported, work on the assessment of raw materials like chromite, magnesite, bauxite, etc. has been in progress.

The work on survey of raw materials has often suffered for want of adequate facilities for evaluating raw materials which requires conducting practical trials on bulk quantities. A proposal for setting up a Unit for the Industrial Evaluation of Ceramic Raw Materials was included in the Third Plan of the Institute and should be sanctioned otherwise this activity would not be of as much benefit.

2. Lead boron free earthenware glazes

There is acute scarcity of lead metal and its compounds. The Institute has been studying the question of replacing lead oxide and borax in ceramic glazes. The performance report of lead boron-free glazes, developed at the Institute, from a wall tile factory has been satisfactory. Maturing temperature of the glaze was lowered to 1120° to suit their tile composition. The glazed tile samples showed extremely high craze resistance.

Factory trials on dinnerware showed slight yellowish discoloration only at the edge where the glaze application was thin.

Adoption of these glazes will eliminate the use of lead oxide and borax.

3. Zircon opacifiers

The Institute has investigated the problem of finding out indigenous substitutes for the imported opacifiers, such as tin oxide and zircon base opacifiers. Processes have been developed to prepare zircon opacifiers from indigenous zircon sand. Samples of these opacifiers sent to factories for trial were reported to be satisfactory and comparable in quality to the imported opacifiers.

4. Steatites

The raw material used in the manufacture of steatites, including those for use in high-frequency, low-loss insulators, is abundantly available within the country. The compositions have been worked out for the manufacture of steatite insulators, resistors, blocks, burner tips, etc. Work is being carried out on the methods of forming where dies made of special steels are required.

5. High alumina refractories (80 to 95 per cent Al_2O_3)

High alumina bricks are used in soaking pits and reheating and other industrial furnaces and are entirely imported. There is a large demand for these bricks in the country.

Refractories containing up to 80 per cent Al_2O_3 with good properties were made from bauxite while up to 95 per cent Al_2O_3 bricks were produced from technical alumina. The properties of bricks fired to 1600°C. were found to be comparable with those of imported bricks.

6. Casting pit refractories

These form a major item of refractories consumption in steel making but the quality of indigenous products is not always satisfactory. As a result, these refractories are sometimes imported in large quantities.

The work in progress at the Institute indicates the possibility of producing better quality refractories by using cheaper raw materials and pyrophyllite.

7. Castables and monolithic linings for furnaces

Castables are now used in considerable quantities as air-setting cements, particularly in boilers and other repair and maintenance jobs. These are mostly imported as quality of the indigenous products made so far is not up to consumers' requirements. Work has been taken up at the Institute.

High alumina cements similar to Cement Fondu have been produced at the Institute.

8. Oxide refractories

Sintered alumina products with up to 98 per cent Al_2O_3 are required for special purposes and high temperature work. These are hitherto entirely imported. Recently manufacture of such refractories has been taken up at the Institute and small items are being made for steel plants, Atomic Energy Establishment and Defence Establishments.

9.- Products of special refractories

Like pyrometer sheaths, pure alumina articles, combustion boats, refractory tubes and plates, etc. The Institute has a production scheme for these items and these are being supplied for several years to the industry, research laboratories and steel plants.

10. Forsterite refractories

Though produced in the country, quality of these refractories does not satisfy the consumers. Hence large quantities are imported. Investigation is in progress at the Institute to produce this type of refractory from cheaper materials like sand or quartz with better properties. Promising results have been obtained.

11. Production of glass electrodes for *p*H meters

Glass electrodes are being produced under the above-mentioned Production Scheme and are supplied to laboratories, instrument makers and other consumers.

12. Production of radiation shielding windows of lead glass

Windows up to 10″ × 10″ size are being regularly produced and supplied to the Atomic Energy Establishment and other institutions.

Production of large windows 40″ × 40″ size, hitherto imported, is being planned.

13. Production of enamel stains and ceramic colours

These are being made under the Production Scheme and supplied to the industry.

14. One coat white or coloured enamelling

A good deal of enamel steel is being imported as low-carbon steels are not produced in the country. The investigation has been undertaken with a view to devising adjustments in the process to suit common grade steel sheets available in the country.

15. Vitreous enamels for cast iron and sheet iron

Possessing high corrosion resistance, are under development.

16. Development of boards and laminates out of waste mica

Asbestos boards, 'limpet spray asbestos', boiler mattresses, 85% magnesia, etc. are extensively used by the Railways and other industries for thermal insulation. The present requirement of the country is met mostly by imports. Boards, laminates and other products comprising mica waste and/or indigenous asbestos along with different bonding materials (organic and inorganic) some of which are under development at the Institute, may substitute some of the imported items.

17. Process Technology for lithium chemicals using indigenous lepidolite as the starting material

Lithium chemicals having diversified uses in indigenous industries are at present being imported. The Institute has initiated a project for developing the process technology for lithium chemicals using indigenous lepidolite which is reported to be available in fairly large deposits and for which there is at present practically no use in the country.

D. APPLIED WORK

(This list does not include problems on which investigations of fundamental nature having a bearing on applied work are being carried out)

1. Study of fuel efficiency of glass tank furnaces

With a view to improving their performance.

2. Rapid analyses of minerals and mineral products

Chemical analyses is vitally important for evaluation and quality control of minerals and mineral products. A new scheme was worked out for accurate analyses of silicate materials in a few hours instead of a few days normally required at present. Investigations are in progress for development of such schemes for rapid and accurate analyses of chromite, zircon sand, bauxite and phosphate minerals, utilising the results of basic researches carried out in the Institute earlier.

3. Alumino-silicate glasses

It was shown earlier that some of the alumino-silicate glasses have highly favourable electrical, thermal and certain other properties. One of the difficulties limiting the use of such glasses is the very high temperature required to melt them at a reasonable rate. This difficulty has been successfully overcome by using an eutectic mixture of talc and clay as the starting material with which formation of clear glass was complete at temperatures around 1380°C. Efforts are being made to explore the possibility of producing insulators, domestic wares, etc. out of this glass.

4. Chemically treated glass

A new method has been developed for improving the mechanical strength, thermal shock resistance and chemical durability of glass articles by thermo-chemical treatment of the surface. Commercial utility of the process is now being explored.

5. Improvements in foam glass

Process developed at the Institute already assigned and utilised for commercial production.

6. Evaluation of sands and other raw materials for the Glass industry

7. Utilisation of magnesites

With particular reference to Almora deposits, in the manufacture of basic refractories.

8. Evaluation of Indian pegmatites

With a view to facilitating mica prospecting on an economic basis, the Institute has been working on the possibility of correlating the concentration of mica with the characteristics of pegmatites and associated rocks.

9. Thermal conductivity studies on vitreous enamel

Thermal properties of enamel coatings constitute an important consideration in the selection of coating for aero-engine parts exposed to high temperature, architectural panels, cooking ware, refrigerators etc.

10. Application of statistical quality control in industry, and productivity

11. **Standard specifications** for glass, enamel, refractories and pottery products and raw materials.

Export Promotion

1. Efficient utilisation of low-grade mica: Objective classification

The Institute has been working in this line for quite some time and has developed a handy apparatus for evaluating mica, particularly of the so called inferior quality (fetching a considerably lower foreign exchange) on the basis of electrical properties. There is a scope for upgrading a substantial proportion of the lower-grade mica. Practical feasibility and economics of introducing objective classification in export trade are being explored.

2. **Beneficiation of low-grade kyanites and low-grade chrome ores** for export promotion and utilisation in the manufacture of refractories.

3. **Testing of products** for quality control, export promotion and Certification Marking.

Research, Development and Production Work on Glass, Enamels, Refractories and Ceramics included in the Programme of other CSIR Laboratories

1.	Studies on Vycor type glass	RRL Hyd.
2.	Study of the suitability of Indian made thermometer tubes	NPL
3.	Silica tube manufacture	NPL
4.	Chemically resistant enamels for lining of reaction vessels and other equipment	RRL Hyd.
5.	Opacified enamels from titanium—Pilot Plant	RRL Hyd.
6.	Production of standard pyrometric cones	RRL Hyd.
7.	Base exchange studies on clays	NML
8.	Preparation of plaster of Paris surgical bandages—Pilot Plant	CSMCRI
9.	Synthesis of silicon carbide grains (for abrasive & refractory industry)	RRL Hyd.
10.	Synthesis of silicon nitride (used in metallurgy and nozzle inserts in rocket motors)	RRL Hyd.
11.	Zircon refractories (used in certain glass tank furnaces and in aluminium refining furnaces)	NML
12.	Mullite refractories	NML
13.	Technical ceramics including ceramic rods for pyrolitic carbon resistors	NPL
14.	Piezoelectric ceramics (for application as ultrasonic transducers in microphones, pick-ups, etc. including barium titanate and lead zirconate transducers)	NPL
15.	Chemical and thermodynamic properties of refractory materials at high temperatures (for use in atomic energy, space research & in ceramic and metal industries)	NCL

Glass & Ceramic Raw Materials

1.	Sodium sulphate from Sambhar Lake bitterns	CSMCRI
2.	Borax (recovery of pure borax from Tincal available at Pugga Valley in Kashmir)	CSMCRI
3.	Synthetic cryolite	NML
4.	Fluorspar	NML
5.	Potassium carbonate (economic method for its production)	CSMCRI
6.	Sea water magnesia for the manufacture of refractory magnesia	CSMCRI

13. Aeronautical Engineering: Aircraft Structures Materials, Propulsion Systems, Aviation Fuel

The areas of interest that have been spelled down for this Working Group of the Conference on Research and Industry in the field of aeronautics are so vast and the time available to us is so short that at best we can try to outline only the major or pressing needs of the aeronautical industry. Looking at the industry and its development in this country during the last twenty-five years or so, the interested groups can be divided roughly into three broad categories: manufacturing organisations like the various divisions of the Hindustan Aeronautics Ltd with its primary facility at Bangalore and the other fast coming facilities at Nasik, Koraput, Hyderabad and Kanpur at one end, and at the other end, research and development organisations like the National Aeronautical Laboratory, the Gas Turbine Research Establishment and the primary centre for aeronautical engineering education, namely, the Department of Aeronautics at the Indian Institute of Science, Bangalore and the aeronautical faculties of the Madras Institute of Technology and the Punjab Engineering College, and in a few more years the various Indian Institutes of Technology with their departments of Aeronautics. In a certain sense, the Technical Centre of the Civil Aviation Directorate may be looked upon in the same category although its interests and responsibilities are much wider. The civil aviation with its two arms, the Air India and the Indian Airlines Corporation and the Defence Ministry with its corresponding military counterpart, the Air Force, are the primary user organisations in the country. It is a well-known fact that the aircraft industry has a pyramidal structure with extensive supporting or backup industries in the areas of materials, components, systems, and instrumentation etc. This paper's chief interest then, will be the areas of primary concern to the aircraft industry in import substitution and the extent to whichthe research and development organisations can contribute in this direction.

To fix ideas, let us for example examine what specific planning is necessary in an aircraft organisation to deliver the end product, i.e. an aircraft certified to fly and perform the role it was designed for. Let us for the sake of argument assume such a project calls for building approximately 15 aircraft of say 70,000 lb. all-up weight, carrying some eighty passengers over a distance of 1000 miles at a speed of 600 m.p.h. and an altitude of 30,000 ft. To illustrate the project planning in its practical rather than some abstract manner, an endeavour is made to present a table (Table 1) giving a breakdown of the prototype development cost of the project for various items listed together with observations whether the cost is in local currency or foreign. The total cost for four prototypes sums up to Rs 15 crores. Extraordinary emphasis will be necessary for taking up a simultaneous development of the special raw materials, the proprietary equipment (such as hydraulics, electrical, electronic, air-conditioning and pressurisation), the power plant, and the aircraft wheels, brakes and tyres, if progressive

Table 1—Development Cost of Four Prototypes of the STOL type of Transport/Freighter Aircraft as proposed by the Advanced Project Group at HAL

		Cost (Rs lakhs)	Percentage total cost	Remarks
1.	Cost of raw materials, standard parts and consumables (allowance made for scrap)	37.5	2.5	Wholly in foreign exchange
2.	Cost of proprietary equipment such as hydraulic, electrical, electronic and air-conditioning and pressurisation etc. (allowance made for spare backing)	142.5	9.5	Wholly in foreign exchange
3.	Cost of engine change unit (4 engines per aircraft plus spares)	187.5	12.5	Wholly in foreign exchange
4.	Fabrication cost for detail parts, assembly and erection of four prototypes, one of which will be unequipped	495.0	33.1	Totally indigenous
5.	Jigs, tools and fixtures sufficient for two prototypes to be assembled concurrently	165.0	11.0	Totally indigenous
6.	Design work	210.0	14.0	Totally indigenous
7.	Wind tunnel work	22.5	1.5	Totally indigenous
8.	Mock-up	21.0	1.4	Totally indigenous
9.	Flight test instrumentation and modification in design systems resulting from flight tests	105.0	7.0	Totally indigenous
10.	Functional and structural testing and ground services	67.5	4.5	Totally indigenous
11.	Capital cost towards extra facilities	46.5	3.1	Totally indigenous
	TOTAL COST FOR DEVELOPMENT	1500	100	

indigenisation of these items is to be completed by the time the series production commences. Table 1 gives the cost breakdown.

The percentage allocations would be somewhat different, with foreign exchange component somewhat higher for other types of aircraft and for production models.

On surveying some of the items listed in Table 1 it will be noticed that the cost of raw materials which for instance makes up only 2.5 per cent of the total cost, is wholly in foreign currency and without which even an empty shell is not possible. Similarly even if we have the material for this shell, it would not fly without the engine for which again we are wholly dependent on foreign exchange. Of the raw material requirements, approximately 80 per cent comprises various aluminium alloys, and of the remaining, 15 per cent is steel and 5 per cent constitutes components made of plastics, rubber etc. Having fabricated the shell, the basic services are furnished with the help of hydraulic, electrical, electronic, pneumatic and other accessories. So far we have completely relied on foreign markets for their supply. The cost of these amounts to nearly 9.5 per cent and all of it in foreign currency. Here again the crucial equipment without which the aircraft is completely useless, is dependent upon foreign exchange. This leads to the second indicator of industrial planning. The HAL has recently taken steps to manufacture under licence some of the items for current projects, so that sufficient know-how would have been acquired by the time any future production is launched and thus approximately half of the foreign exchange incurred on these items would be saved. However, complete independence of foreign sources would largely depend on how quickly expertise and accessory manufacture are established and mastered in the country. Some of the CSIR laboratories could help to accelerate this process of components and instrument manufacture but much greater professional exchange of ideas would have to be made before this could materialise in a concrete form.

The wind tunnel testing cost at 1.5 per cent of the total is shortly expected to be mostly indigenous. This is based on the assumption that the National Aeronautical Laboratory tunnels would be fully commissioned shortly for high speed testing. The low speed tunnel work can be performed at the Indian Institute of Science with the facilities at present available there and also at the HAL itself with the commissioning of HAL low speed test facility.

It will be noted that the power plant consumes a fair amount of exchange involving about 12.5 per cent of the total cost. The sophisticated engines which must be reliable both in performance and in its mechanical operation require greater lead-time for their perfection. The industrial planners must think far ahead if suitable engines have to be made available to the aircraft manufacturer in time for his project planning. The complexity involved in engine development may be illustrated by taking an example from our present experience. An engine like Bristol Orpheus which is at present being manufactured under licence contains parts made from anywhere up to 350 different metallic alloys both ferrous and non-ferrous ranging over a broad spectrum of compositions. If we make a typical estimate of our requirement, in some of these alloys, over a period of time we will be requiring as little as a few tens of pounds and in some others as much as a few hundred or a few tens of thousands of pounds. With our incipient technology in both ferrous and non-ferrous alloys, it is clearly out of question for us to undertake a project planning based on such production requirements. This immediately brings home to us the necessity for developing a philosophy of rationalisation of our material requirements. While most certainly we must take steps now to produce these various alloys eventually, we cannot afford to think of using such a large variety of alloys in indigenous manufacture immediately, as it becomes too expensive and time consuming. We therefore need to determine on a rational basis the minimum number of alloys we need to make, which in turn would enable us to make power plants (and of course the airframe too) from wholly indigenous sources. Such a philosophy of material procurement may cause some complications in design but nothing that is insurmountable. Wg. Cdr. Roy Chaudhuri and his colleagues at the G.T.R.E. looked into this problem in some detail and concluded that we may perhaps be able to reduce the number of essential alloys for the engine to say about 30 to 40 per cent. Their analysis is based on a study of the chemical composition of the different alloys, group them on the basis of composition similarities and choose a representative composition characteristic of the group. This characteristic composition may be already known alloy, with known mechanical properties and a good knowledge of its heat treatment characteristics etc. in which case the immediate problem will be one of gearing down to production of such an alloy in the quantities required. If it is not a known composition, but only a representative composition of the group, there will be need for some developmental work to make the alloy, investigate its heat treatment characteristics and mechanical properties to determine its suitability before production of such an alloy is undertaken. It will be noted that with such a philosophy, the size of the production batches will be much larger than would be possible otherwise. There appears to be a very strong case in support of such a philosophy and the appropriate CSIR laboratories and other Governmental laboratories and industries need to take a serious look into this problem. There is in addition to the material requirements outlined above, a vital need for well trained professional and technical manpower in the various specialists fields which go to support the aeronautical industry as a whole.

Having outlined the major areas where immediate attention is required in import substitution, we need to ask ourselves what specifically is it that the research and development organisations can contribute in this respect. This is a question that requires careful consideration, bearing in mind our limitations in equipment and technical manpower and the projected expansion of our own individual organisations. An effort is made in what follows to assess this capability for the Department of Aeronautics of the Indian Institute of Science and the National Aeronautical Laboratory. We welcome such assessment and commitment from other organisations also that can possibly contribute to the growth and indigenisation of the aeronautical industry in this country.

The Aeronautics Department of the Indian Institute of Science has been at the vantage point for the last 25 years or so and it has been the primary source of supply for the aeronautical professional manpower in this country. In addition to this, it has carried on extensive research in fundamental problems in the past and actively participated in the development of HT-2, HF-24 and HJT-16 through its wind tunnel facilities. More recently, the staff of the department has also started participating in the advanced projects group activities of HAL. The primary areas of participation in the immediate defence effort are in technical know-how of the staff in advanced methods of analysis and the tunnel facilities. It may not be inappropriate to point out here that their major test facility, the 9′ × 14′ low speed wind tunnel can be made considerably more useful if the flow conditions in the tunnel are further improved and a wider variety of test equipment made available. Any financial investment made in this direction will be certainly very worthwhile considering the increased reliability and utility that ensues.

By far the most important task of this Get-Together is to obtain a sense of direction to the activities of the National Aeronautical Laboratory, the premier CSIR Laboratory in the field of aeronautics. But before we do that it would perhaps be better to recall the comments made by Shri Raj Mahindra. In discussing the problem of import substitution he argues in his paper "In recommending that the CSIR laboratories should increasingly partake in the development of aircraft accessories industry, I would like to add a note of caution concerning the future work at the National Aeronautical Laboratory, and it is, that the NAL should be wholly oriented to the needs of aircraft industry alone. There is always a danger for the national laboratories to take up all sorts of work when there are so many technically and scientifically deficient areas in the country. My advice, whatever it is worth, is that the NAL should resist any such temptation and address itself to the task of making aircraft industry technically self-sufficient and not try to show its prowess in other distantly related fields." Speaking for the NAL, I would like to assure that in the years to come, the primary and foremost interest of the Laboratory will be aeronautics. Any effort presently undertaken in distant fields will be downgraded unless it happens to be of immediate national interest and no attempt will be made to solicit work from industry other than aeronautics. If any help is sought from the sister organisations of CSIR in fields in which we have technical competence, we will certainly render such help.

The primary facility of the National Aeronautical Laboratory is a 4′ × 4′ trisonic wind tunnel which is expected to be commissioned by about this time next year. It will be deeply committed to the research and development activities of the HAL. A smaller aerodynamics test facility is a 1′ × 1′ trisonic tunnel which will be commissioned by about the middle of March 1966. Several problems of indigenous origin have been posed which will require fairly extensive usage of this tunnel. Our computer facilities which are fully committed again are involved in work concerned with national effort of importance. Our electronics and instrumentation section is deeply committed to producing in numbers various measuring devices such as pressure transducers; displacement, velocity and acceleration pickups; temperature sensing devices; strain gauges and associated instrumentation, all these items being of considerable importance in our national effort in import substitution. These are items for which requirements are indicated by various laboratories in addition to the NAL's own continued demand in the field of special instrumentation. In recent visits of our scientists to the various defence establishments, problem areas have been identified requiring investigations both of a theoretical and experimental nature. Our propulsion group which has started fairly recently is involved to quite some extent in areas of immediate interest to the defence ministry. One long term project which is at present under serious investigation with a view to preparing a project report is the propulsion wind tunnel. The preliminary specifications for which analysis is being made at present are as follows: Altitude range 0 to 70,000 ft, Mach number range varying from 0.6 at sea level condition to 3.0 at 70,000 ft altitude; size of free jet 18″ diameter and size of test units up to 10″ diameter and a mass flow of 90 lb. per sec. and a pressure ratio of 3 to 1. Such a tunnel with all the associated equipment is estimated to cost about Rs 2 crores and there is a strong need to determine the technical feasibility and the extent of utility in the light of our anticipated power plant design requirements.

In order to study in detail the high-speed aerodynamics and dynamic stability problems of projectiles and missiles, it is also proposed to set up at NAL an aero-ballistic range, to the following outline specifications:

1. Range diameter 5 ft
2. Range length, 500 ft, with provision for extension in stages up to 1000 ft
3. Range capable of being pressurised up to 100 p.s.i.g. and evacuated to 1 p.s.i.g. or less, in order to obtain a wide range of Reynolds number and dynamic pressures

4. Initial launch velocities up to 5000 ft/sec. to be extended to much higher values as part of developments in the design of high performance launchers

Such a range, apart from providing free-flight investigations over a range of simulated velocity and altitude conditions, will also serve as a complementary facility to the supersonic tunnels for testing under support interference free conditions. Further, it will allow the first steps towards achieving hypersonic Mach number test capability.

We welcome comments and suggestions from interested parties concerning the utility of the above for their own work.

Our structures division which is yet to be fully developed will be concerned with methods of analysis and obtaining strength in those areas where there is need (such as aeroelasticity, thermoelasticity, plasticity, creep, fatigue, etc.) and where it is not considered practicable for HAL to set up such groups in the near future to organise activity from a basic viewpoint. Our materials division which is also in a similar stage of development will be concerned with answering the broad question: 'What makes materials behave as they do, both from the microscopic and macroscopic viewpoints and stressing primarily an interdisciplinary approach'. We believe that a fuller understanding of the engineering properties of the materials is needed before the aeronautical engineer can design optimum structures.

In the light of the developments during the last few months in our own country, the following areas of activity have been explicitly undertaken at the NAL for immediate action.

1. Commissioning the 1′×1′ tunnel before the end of March 1966 and putting it to use to solve problems of immediate national interest.

2. Expedite the work on the 4′×4′ tunnel so that it can be committed to developmental work associated with HAL activities.

3. Develop and produce a line of electronic measuring instruments for pressure, displacement, velocity, acceleration and temperature and strain gauge instrumentation as already indicated previously.

4. In their recent visits with various scientists and officials at the Defence laboratories, our staff scientists have identified various problems which could be tackled in our laboratory. Considerable attention is being given to the solution of these problems.

Before I close the reading of this summary paper prepared by the convening committee, I should like to point out some explicit areas of work which require immediate attention. There is urgent need for producing aircraft quality aluminium alloys similar to the 2017, 2024, 7075 and 5052 series of the ASM specifications. The first two are alloys of aluminium-copper system, the first one being used mostly for rivets and the second for airframe; the third is an alloy of the aluminium-zinc system used where high strength is of consideration and fatigue is not of much importance and the last one is an alloy of the aluminium-magnesium system, used for casting work quite frequently. There are other alloys also, but these are the ones used primarily. The requirement for the immediately anticipated construction at the HAL, Bangalore division is about 3000 tons, but with Nasik division coming up, and if we take Kanpur also into consideration it will be about 5000 tons. This is a relatively small quantity compared to the current annual production of aluminium in this country but requires heat treatment furnaces, rolling mills etc. that may not at present be available in the country. But these alloys are so crucial for the aeronautical industry that this committee recommends to the Government that immediate action be taken to enable the industry to start producing these alloys.

The requirements in alloy steels are also correspondingly very critical. Even if it is uneconomical to produce them in small quantities, the committee recommends that immediate action be taken in this field also to enable the industry to start producing these alloys. Here again the requirements of the Bangalore division of HAL are of the order of 750 tons for the airframe division and about 100 tons for the engine division. The 100 tons comprise high strength and high temperature alloy steels such as Chrome-moly, Chrome-nickel etc. and Nimonic. It may be necessary to undertake production of these alloys on a batch production basis at the Durgapur alloy steel plant.

The components division of HAL will be undertaking production of most of the components going into the plane. The main navigational systems are already being manufactured by the BEL. However, there is still need to make some special accessories such as sockets, plugs, engine starting panels etc. The industry is invited to participate in producing these items.

14. Buildings, Roads, Civil Engineering Materials

During the Fourth Five-Year Plan period, the construction component of the different development activities would cost about Rs 8000-9000 crores. Since building materials generally constitute 70 per cent of the cost of construction investment, this would work out to be of the order of Rs 6000 crores. Approximately one half of this amount will be spent on the products of certain organised industries such as cement, steel, asbestos sheets, bitumen, G.I. sheets, etc. whereas the other half will be spent on materials produced by indigenous methods, such as bricks, tiles, aggregates, sand etc.

The break-up* of the quantum of civil engineering materials required during the Fourth Plan period, for cement, steel, timber and bricks etc., is reported in Table 1.

It is seen from Table 1 that the total requirement during the plan period, of cement will be about 80 million tonnes, of steel about 25 million tonnes, of timber about 8.5 million cubic metres, of bricks about 11,000 crores, of bitumen about 3.5 million tonnes and of cast iron pressure pipes for water supply about 1.7 million tonnes.

In so far as stone aggregates are concerned, it is rather difficult to correctly assess the quantity required, but it will doubtless be very large indeed, as this forms the exclusive material of construction for most of the civil engineering projects. The other civil engineering materials which form only a small percentage of the plan estimate, consist of paints, glass, hardwares etc.

Objective of the Get-Together

The objective of the present Get-Together between Research and Industry, therefore, is to pool expert knowledge in the country to find out ways and means of:

1. Cutting down imports
2. Increasing exports
3. Substituting standard construction material wholly or partly with indigenously available materials with a view to achieve maximum economy

A discussion of these aspects will incidentally bring in the question of the results of research available in the country, their utilisation and the organisational difficulties involved.

Thirty-seven papers have been contributed by the various authors to this particular Group, touching upon different subjects. It is seen that

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*Information supplied by National Buildings Organisation, New Delhi

Table 1—Requirement of Building Materials during Fourth Five-Year Plan

Items	Cement (lakh tonnes)	Steel (lakh tonnes)	Timber (cu.m.)	Bricks (crores)
(1)	(2)	(3)	(4)	(5)
1. AGRICULTURE				
(i) Agricultural Production	21.70	4.46	1,41,322	391.01
(ii) Minor Irrigation	29.00	3.80	—	475.00
(iii) Soil Conservation	1.08	0.14	19,000	24.80
(iv) Forestry	2.07	0.37	27,000	37.34
(v) Animal Husbandry	3.04	0.63	16,400	54.00
(vi) Dairying & Milk Supply	1.16	0.21	17,000	26.80
(vii) Agricultural Marketing & Warehousing	2.94	0.65	14,700	44.00
(viii) Fisheries	3.30	0.43	58,000	76.00
(ix) Community Development	6.76	0.98	200,000	288.20
(x) Cooperation	4.25	0.80	106,000	79.50
For Public Sector	75.30	12.47	5,99,422	1,496.65
For Private Sector	83.00	5.60	2,70,000	674.00
Sub-total for Agriculture	109.30	18.07	8,69,422	2,170.65
2. IRRIGATION	80.00	6.00	5,60,000	400.00
3. POWER	55.95	29.75	8,20,000	438.50
4. SMALL INDUSTRIES	31.25	6.88	6,250	468.75
5. ORGANISED INDUSTRIES	121.60	41.70	4,94,000	854.00
6. TRANSPORT				
(i) Railways	44.50	55.00	7,10,000	369.00
(ii) Roads	19.20	5.60	—	60.00
(iii) Road Transport	2.50	0.53	7,900	41.50
(iv) Inland Water Transport	—	—	—	—
(v) Ports & Harbours	6.20	1.21	1,720	26.00
(vi) Shipping	—	—	—	—
(vii) Air Transport	3.09	0.68	12,175	17.42
(viii) Tourism	1.13	0.15	19,700	25.88
(ix) Lighthouses	0.31	0.08	1,663	3.10
(x) Meteorology	0.20	0.03	4,000	4.60
(xi) Information & Broadcasting	1.50	0.48	11,375	16.50
(xii) P & T	6.50	1.56	77,100	111.70
Sub-total for Transport	85.13	65.32	8,45,633	675.70
7. EDUCATION	30.00	6.42	3,96,000	582.00
8. SCIENTIFIC RESEARCH	1.75	0.51	16,000	21.35
9. HEALTH				
(i) Health Schemes	26.64	6.31	3,20,400	483.12
(ii) Water Supply	9.30	16.40	—	222.00
Sub-total for Health	35.94	22.91	3,20,400	705.12

Contd

TABLE 1—*Contd*

(1)	(2)	(3)	(4)	(5)
10. HOUSING & CONSTRUCTION	140.00	19.94	34,20,000	4,474.00
11. WELFARE OF BACKWARD CLASSES	2.46	0.32	43,050	56.60
12. SOCIAL WELFARE	0.09	0.01	1,425	1.95
13. CRAFTSMEN TRAINING & LABOUR WELFARE	6.53	1.66	72,880	110.95
14. PUBLIC COOPERATION	—	—	—	—
15. RURAL WORKS	0.50	0.06	—	25.00
16. REHABILITATION	2.50	0.33	43,750	57.50
17. MISCELLANEOUS	2.50	0.46	36,750	48.50
TOTAL	705.50	220.34	72,07,560	11,090.57
DEFENCE	33.75	6.00	5,91,600	636.00
CONSTRUCTION COMPONENT OF NON-PLAN EXPENDITURE OF STATES	10.00	1.80	1,50,000	230.00
TOTAL FOR FOURTH PLAN CONSTRUCTION	749.25	228.14	79,49,160	11,956.57
ADD 5% FOR MAINTENANCE ETC.	37.45	11.41	3,97,458	597.33
	786.70	239.55	83,46,618	12,554.40
FOR BRICKS DEDUCT 15% FOR STONE				(−)1,883.16
GRAND TOTAL	786.70	239.55	83,46,618	10,671.24
Say	78.7 million tonnes	23.96 million tonnes	8.35 million cu.m.	10,670 crores

NOTE — Requirements of cast iron pressure pipes for water supply purposes are 1.7 million tonnes, and that of bitumen about 3.5 million tonnes

there have been 3-4 papers on each of the following subjects: light-weight aggregates; asbestos cement; substitution of cement with cheaper material; lime puzzolana mixes; soil as a material of construction; modern methods of design of structures; new techniques of construction; need for organised consultancy services; utilisation of the results of research etc.

The information embodied in the papers received and that available from literature have been drawn upon while presenting this paper to the Working Group on civil engineering materials. The subject has been discussed material-wise.

Cement

The cement required for civil engineering jobs during the Fourth Plan period is of the order of 80 million tonnes as against the total estimated production target of about 100 million tonnes. At the end of the Third Five-Year Plan period, the production of cement will be short of the target by about 2 million tonnes.

In view of the increased and increasing defence requirements coupled with the back log of about 2 million tonnes per annum, there would be an acute shortfall of cement required for various civilian construction projects. It is, therefore, necessary that steps should be taken so that within the plan allotment, the production of cement should be augmented. At the same time, steps have also to be taken to find out ways and means by which the consumption of cement is reduced, resorting to alternative materials which would substitute for cement either partially or wholly. The shortage of cement could be offset to the extent of 5-10 per cent by providing vertical type of kilns with a capacity of 150-250 tonnes at suitable places where limestone deposits are not extensive enough to justify the setting up of larger plants using rotary type of kilns. Such an approach will avoid both long haulage and prolonged storage of material, thereby resulting in greater economy to the users.

Use of blast furnace slag and fly-ash which are available as waste product from industry, should be encouraged. A list of some of the industrial wastes* which are available in large quantities and can be economically utilised in the manufacture of building materials is given in Table 2. These steps will serve to reduce the cement shortage at least to some degree.

Economising on the Usage of Cement

As a result of recent researches both in India and abroad it is now possible to reduce the consumption of cement in the manner mentioned below without in any way compromising upon the scientific requirements.

Use of modern design methods. A substantial quantity of cement can be saved by following modern design methods such as (i) Adopting prestressed concrete construction in preference to reinforced concrete construction wherever practicable. This will not only save on cement but also on steel. (ii) Introducing burnt brick[1] in rigid pavements for road construction along the neutral axis of the plain concrete slab where stresses are low and therefore do not necessitate the use of stronger materials. (iii) Adopting flexible type pavements for roads and runways in lieu of rigid type pavements wherever practicable. (iv) Adopting new construction techniques, such as use of shell roofs, use of light-weight concrete etc. (v) Using locally available binders, such as lime-puzzolana mixes, lime slag cements, magnesium oxychloride cement, lime gypsum etc. (vi) Taking greater care in the storage of cement by improving on the existing practices of using gunny bags. (vii) By producing more than one type or grade of cement so that the higher grades are not wasted on jobs where inferior grades would suffice.

Asbestos Cement

The asbestos cement industry had a capacity of 5.5 lakh tonnes per annum at the end of 1963. It is now expected to increase the capacity to 7 lakh tonnes per annum. The asbestos used by the industry is of the chrysolite variety which is imported at present at a cost of Rs 7-8 crores per annum.

As a result of research work carried out in the country[2,3] and supported by successful pilot plant trials at Jealgora, it has been shown that the

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*List made available by Indian Standards Institution, New Delhi

Table 2 — Materials from

Industrial waste	Annual yield	Product that can be manufactured	Approximate cost of the plant for processing
(1)	(2)	(3)	(4)
Blast furnace slag	**About 6 million tonnes**	**Foamed slag**	**Rs 20 millions**
		Foamed slag	**Rs 0.2 millions**
		Air cooled slag	—
		Granulated slag	—
		Slag lime bricks	**Rs 2.4 millions**
		Slag wool	—
		Lime slag cement	—
Fly-ash	**Up to 3.5 million tons**	**Sintered light-weight aggregate**	**Rs 5 to 9 millions**
		Lime fly-ash mortar	
		Portland puzzolana cement	**Rs 5.7 millions**
			Rs 0.88 millions for supply in the bags

Industrial Wastes in India

Plant capacity	Cost of finished product	Use to which it can be put	Remarks
(5)	(6)	(7)	(8)
150,000 tonnes per annum	Rs 6.60 per m.^{3}	Light-weight aggregate for concrete	Feasible at most of the Steel plants. Bed method recommended. Concrete made of these aggregates possesses heat and sound insulation
70,000 tons	Rs 3.50 per m.^{3}	Dense aggregate for concrete, base course material in bituminous pavements etc.	Particularly economical in the Indo-Gangetic plain where the usual aggregates cost more
—	Rs 9 per m.^{3} including crushing, screening etc.	—	
—	—	For the manufacture of cement	All Indian slags are suitable for this
60 million bricks per year	Rs 40 per 1000 bricks	Bricks for building	Compares in strength to clay bricks and is cheaper
—	—	—	Excellent thermal insulating properties
—	—	Instead of cement in masonry which is not heavily stressed	
400 tons of aggregate per day	Rs 35 per 100 ft^3	Light-weight aggregate for the manufacture of blocks etc.	
—	Lime fly-ashs and : 1 : 1 : 1 mortar Rs 35 per m.^{3}	In place of cement mortar. Cement : lime : sand 1 : 1 : 6 costs Rs 60 per m.^{3} Cement : sand 1 : 6 mortar costs Rs 50 per m.^{3}	All fly-ashes available in the country suitable
Intergrinding plant of 600 tonnes per day	Rs 15 less per ton with 20% replacement of cement	—	Some fly-ashes like the Neyveli fly-ash have shown cementitious property in addition to puzzolanic property
Blending plant of 300 tonnes per day	Rs 20% replacement of cement per ton less by Rs 13.50 for new bags; Rs19.50 for old bags; Rs13.50 for bulk supply	—	

Contd

TABLE 2—*Contd*

(1)	(2)	(3)	(4)
Fly-ash			Rs 0.24 millions
Cellular concrete (Lime & fly-ash as raw material)	—	—	Rs 4 millions Rs 8.5 millions Rs 11 millions
		Light-weight aggregate	Rs 5.5 millions
Sugar pressmud	About one million tons thrown waste	Building lime	Rs 140,000
Cocount husk	About 450,000 tons go waste	Particle board	—
Coconut pith	—	Expansion joint filler	Rs 51,000 capital investment; Rs 86,000 liquid capital
Furnace clinker	—	Building block with crushing strength ranging from 30 to 70 kg./cm.^{2} in the density range 1100 to 1400 kg./m.^{3}	Rs 0.14 millions
Water works silt		Light-weight aggregates	Rs 2.5 millions

(5)	(6)	(7)	(8)
Just bagging for use in site 60 tonnes per day	Rs 27.50 per tonne for old bags; Rs 19·50 per tonne for new bags	With 20% replacement at site saving of Rs 22 to 24 per tonne of cement	More suitable in mass concrete and marine structures
28000 m.³ per year 91000 do 138000 do	Rs 70/m.³ Rs 57/m.³ Rs 53/m.³	Construction of wall etc. Equivalent to 500 bricks	Saving of Rs 5 per m.², Rs 8.50 m.², Rs. 9.50 m.² of wall with cellular concrete bricks
Sintering plant 6000 m.³/day	Rs 10.60 per m.³	As light-weight aggregate in concrete	
2100 tonnes of lime per year	Rs 47.48 per ton	In place of lime from limestones which costs Rs 90 per tonne at kiln sites	Sugar press mud can also be used for the manufacture of mineral wool for insulating industry distemper, retarded cement etc.
—	¾" thick board 0.37 per ft²; 40 lb./ft³ boards at Rs 260 per ton	Would be cheaper than boards made of wood or bagasse as only 0.5% of paraformaldehyde resin is needed as against 6 to 9% for boards of wood, bagasse etc.	Even if 10% of the waste is utilised 40 millions ft² board, ¾" thick (density 40 lb./ft³) can be made
30,000 m.²	Rs 9.45 per m.² (Re 0.88 per ft²)	Marketed material of joint filler wastes Rs 15 per m.². Used in place of fibre board impregnated with bitumen	Cashewnut shell liquid and aldehyde resin are required for manufacture
800 blocks per annum of size 10×20×40 cm.	Cinder concrete blocks 1 :6 (64 kg./cm.²) Rs 188 per 100 blocks; 1 :9 (38 kg./cm.²) Rs 129 per 1000 blocks	With bricks Rs 118; with 1 :6 blocks Rs 95; with 1 :9 blocks Rs 80	Cannot be used in reinforced concrete work as it caused accelerated corrosion. Blocks suitable for load bearing and partition walls of two storey buildings
150 tonnes per day (0.15 million m.³ per annum)	Aggregate ex-works Rs 10 per m.³	In place of usual aggregate for concrete in certain regions like Calcutta cheaper even if sold at Rs 18 per m.³; saving of Rs 10 per m.³ in concrete	Can be used for the manufacture of solid and perforated bricks also

indigenously available asbestos (amphibole) can be advantageously used after judiciously opening up the fibres, without causing crushing of the fibres. The asbestos prepared in this manner require only 10-20 per cent of the imported asbestos to be mixed with the local asbestos in order to prepare A.C. Sheets conforming to standard specifications.

Use of Puzzolanic Material

As a result of investigations carried out by various laboratories[1,2,4] it has been established that cement for concrete works can be replaced to some extent, by using reactive surkhi or fly-ash without affecting the strength requirements.

As a result of a recent survey, it has been found that there are available large deposits of clays, which when burnt will yield reactive surkhi, besides about 4 million tonnes of fly-ash which will be available from the thermal plants during the Fourth Plan period.

Puzzolanic mixtures as mentioned above, can also be used with lime to fully replace cement-sand mixes as used at present in mortars and plasters in building construction.

Since cement is sought to be replaced to a very large extent with lime in one form or the other, it will necessitate the organisations of lime industries in the country on proper scientific lines[4].

Light-Weight Aggregates

In the present context of housing shortage, emphasis has been laid on pre-fabrication and multi-storeyed construction. This will require light-weight materials to be used for panelling and other similar jobs. Studies carried out in India[2] have shown that furnace clinkers, cinters, foamed or expanded slag, bloated clay aggregates can be successfully used for making light-weight aggregates, which are found to be suitable for making nonload-bearing and load-bearing walls only. Sintered fly-ash and bloated clay aggregates are suitable for making structural concrete.

Aerated concrete is another material, which can be advantageously used for similar jobs.

By adopting the above techniques, about 17 million tonnes of cement is estimated to be saved during the Fourth Plan period.

Timber

In the context of acute shortage of timber, rational utilisation of timber resources and organised development of timber industry has a considerable part to play in achieving economy. In the past, teak and some popular type of species have been used for all needs but during the past 15 years many secondary species have come into use, which would need grading of the timber. Attempt to classify timber has already been taken in hand by Indian Standards Institution on a national basis.

For timbers intended for structural purposes such as purlins, rafters, beams etc., the various species have been grouped under three heads, super, standard and ordinary. The proper use of timber will result in considerable savings.

The industries based on timber waste products such as particle board, etc. can also fill the gap in our need to a certain degree.

Soil as a Material of Construction

It has been stated earlier that out of Rs 6000 crores allotment towards the cost of civil engineering materials during the Fourth Plan, about Rs 3000 crores will be towards the cost of stone aggregates, bricks etc. The main use of these materials is towards the construction of roads, runways, irrigation, housing etc.

Stone and brick had mostly been used for such construction, due to the fact that these materials have high strength not only in the dry condition, but also when soaked.

As a result of recent researches carried out, both in India and abroad in the domain of soil science, it has been shown that the engineering properties of almost all types of soils, can be improved considerably both in the dry and wet conditions. The soil thus improved is rendered fit for use in certain types of constructions without compromising on scientific requirements.

Some of the proven results of research which have stood the tests of field trials are :

(a) Local soil compacted at optimum moisture to a high density resulting in a CBR of about 8 under soaked conditions.

(b) Mechanically blended soil (improved grading as a result of mixing the local soils), compacted as in (a) above resulting in fairly high compressive strength in the dry condition and a soaked CBR of about 15.

(c) Soil compacted with small concentration of lime and cement to give a soaked CBR of about 25. The strength in the wet condition is about 150 lb./sq. in.

(d) Compacted soil aggregate mixtures (Mehra's method). Average CBR 35 resulting not only in reasonably high strength in dry condition, but also fair amount of resistance to abrasion.

(e) Compacted graded gravel mixtures resulting in a soaked CBR of 60.

(f) Soil compacted with 5-7 per cent cement resulting in a soaked CBR of about 100, and compressive strength of about 300 lb./sq. in.

The comparative cost of treatment of soils with different binders, as suggested above, is given in Table 3.

It will appear from the above, that the strength of soil can be increased so as to render it fit for replacing brick or stone in various stages of civil engineering construction, at almost half the cost of the conventional material. It will not be out of place to give an idea of the amount of saving that can accrue by substituting the conventional construction material with processed soils wherever the strength requirements justify such replacement of stone or brick with soil.

Table 3—Strength of Soil with Different Binders

1.	Soil stabilised with 5-7% cement	Rs 50-60 per 100 cft	Consolidated crust
2.	Soil gravel mixture properly graded	Rs 45-50 per 100 cft	do
3.	Local inferior aggregates	Rs 40-45 per 100 cft	do
4.	Soil stabilised with soft aggregate	Rs 40-45 per 100 cft and Rs 50 with stone grafting	do
5.	Local soil compacted with small concentration of lime or cement	Rs 30-35 per 100 cft	do
6.	Blended soil compacted to a minimum dry bulk density of 1.8 gm./cc.	Rs 21 per 100 cft	do
7.	Locally available soil compacted to a minimum dry bulk density of 1.75 gm./cc.	Rs 15 per 100 cft	do

Roads

A sum of about Rs 900 crores is likely to be spent on roads during the Fourth Plan period. According to the Government of India Road Development Plan for 1961-81, the total amount which is likely to be spent is of the order of Rs 6000 crores for a length of about 3 lakh miles.

Since the number and weight of the vehicles using the roads today have increased considerably, the thickness of road crust adopted in the past are inadequate; in addition some of the areas are getting waterlogged requiring still higher thicknesses, sometimes of the order of 30 in. If such thicknesses were to be built according to the conventional method, using stone boulders or burnt brick in the lower layers and stone metal in the upper layers, the cost would be very high indeed. The same thickness can however be built up without affecting the scientific design by replacing lower layers with comparatively weaker materials at a very much smaller cost and providing hardstone at the top of the crust only for a couple of inches. This will also be in conformity with the scientific requirements of pavement design, because the stresses due to traffic are high only in the top few inches and comparatively very small at the lower depths, which would not justify using the same strong material throughout the entire designed depth. The suggested replacement with local processed soils in this manner, will bring about a saving of a few hundred crores of rupees during the 20-year plan period.

Runways

The present-day runways, if built according to flexible pavement specifications will require a thickness of about 45 in. which would normally be laid in hardstone. This thickness can also be built up by providing weaker material in the lower layers and strong material only at the top 6 to 8 in. Such techniques have already been tried out[1] in the field and found to result in a saving of about 40 to 50 per cent (about Rs 20 to 30 lakh per runway). Even when cement concrete specifications are adopted the base need not be necessarily built up in hardstone metal as is practised now. The same can be replaced with soil stabilised with cement at a very much lesser cost.

Houses

For construction of rural housing, there is a provision of Rs 670 crores under the private sector and another Rs 100 crores under the Social Housing Schemes. The houses at present are built in burnt brick which is a big drain on transport, coal, petrol etc. and can be avoided by using soil stabilised with cement. This will not only reduce the cost of a wall by about 50 per cent but will also enable the targets to be achieved quickly. This is based on the practical experience gained by India during the construction of 4000 cement stabilised houses during 1948-49. This is the biggest civil engineering project of its kind in the world.

Semi-permanent Houses

The temporary houses built in the villages today, require very frequent maintenance and take much of the time of the farmers which can be usefully utilised elsewhere.

As shown in Table 3, well compacted soil in the dry condition, has reasonably high strength to render it fit for use in the walls of the village house, but on account of poor resistance to water, it will not be able to stand during rains. In order to obviate this difficulty, the compacted soil walls can be given water-proof rendering coat to offer the necessary protection against rains.

This is only by way of an illustration and it is certain that similar saving can also be effected by resorting to the use of soil in most of the Irrigation Projects, such as construction of dams, embankments etc. Use of soil-cement blocks and lime-sand-surkhi blocks has already been recommended[4] for protection of river banks.

The technique of compaction of soil for use in the embankment construction in railways, is of particular importance, especially when it is planned to increase the speed of the trains.

This is all the more important in areas, where the locally available material is fat clay and is used to build up the embankment. In order to avoid the formation of soft spots under the rail-track during monsoon, resulting in loss of speed etc. it is advisable to stabilise the top crust of the embankment, with local soil stabilised with lime, in preference to use of stones, which are likely to sink into the soft subgrade.

Foundation Engineering

Some of the research laboratories in India have gained the required level of professional competence for undertaking consultancy assignments on major foundation projects.

As per example, in the design of foundation for multistoreyed buildings[2] and foundation problem in seismic zones[5] etc., a good deal of work has already been done.

One of the national laboratories[1] is presently acting as consultant on several foundation projects involving soft ground, marine swamps, landslide problems and harbour structures which would have otherwise, in the normal course of things, been referred to foreign experts; but the demand for foundation consultancy services is so great that the concerned national laboratory cannot cope with it because it is constrained to limit the amount of consulting work that it can undertake without deteriment to its normal programme of research. In order to meet this demand and to largely eliminate the dependence on foreign 'expertise', there is an imperative need to augment the existing facilities in the concerned national laboratories, by authorising them to have a cell exclusively devoted for the purpose and run on a commercial basis. Considering the inexorable demand for such services by the civil engineering profession in this country, the need for concerted effort towards organising a cell in the concerned national laboratories is clearly established.

Traffic Planning

The tremendous increase in road traffic in urban areas due to all-round industrial development has resulted in an alarming increase in road accidents. The metropolitan cities in the country have reached a stage, where spot improvements alone will not suffice so that a comprehensive traffic and transportation planning has become necessary to meet the demands of the present as well as future traffic requirements.

Comprehensive planning has been undertaken in a few metropolitan cities with the technical aid of foreign experts against foreign exchange. Since the technical know-how is already available within the country, such types of jobs should, in the fitness of things, be undertaken by one of the national laboratories.

Bituminous Products

At present in India bituminous products that are needed in Road industry such as jet resisting bituminous material, improved bitumastic sealing compounds, modified tars and pitch-bitumen binders, are not readily available. It is, therefore, suggested that industries which are primarily bitumen and pitch based should undertake either directly or by setting up ancillary units to manufacture these improved bituminous products for road industry. This can best be done in collaboration with the concerned national laboratory[1].

Another material which can be economically utilised in the manufacture of philip boards to accommodate structural movements is coconut pitch which is available as a waste product from Coir Industry of the quantities of the order of 3.5 lakh tonnes.

Bridge Bearings

One of the major civil engineering constructions proposed during the Fourth Plan period is the construction of a large number of bridges. A major component involving foreign exchange is the bearings for bridges which are invariably imported.

It would appear that the possibilities of using rubber bearings for bridges and undertaking their manufacture indigenously by providing assistance to the rubber industry deserve to be fully explored with a view to economise on foreign exchange.

Manufacture of Machinery

Except for specialised types of construction, machinery has not, generally been used in India on account of labour being cheaply available.

As a result of new techniques having been recently introduced so as to bring about economy, it is not possible to enforce specifications effectively employing manual labour only. It would, therefore, be essential to have the necessary machines made available for such jobs.

With this objective in view it is suggested that the following steps may be taken :

1. A committee of representatives from the Ministry of Commerce and Industry, the laboratory concerned and the leading manufacturers in the line, should be set up to assign priorities and to size up the requirements.

2. A cell for design and fabrication should be set up ensuring close collaboration of the different organisations concerned.

Utilization of the Results of Research

Despite much useful research work already carried out in the various laboratories in India, leading to results of practical importance, it had not been possible to achieve the desired goal.

In some cases, even when the results had stood the test of field trials and economy had been claimed on the basis of field evidence, certain techniques could not be 'sold' to the prospective users. This had naturally been worrying the Government of India who are directly or indirectly the beneficiaries. As a consequence the Planning Commission in consultation with the scientists constituted 'Assessment Committees' (consisting of experts in the line) separately for Roads and for Buildings.

The *modus operandi* of the Assessment Committee is that certain techniques considered by the Committee as worthy of adoption in the field will be recommended to the States for implementation. The States may, however, have certain amount of hesitation to try the new technique, which may lead to failure. A sum of Rs 1 crore has been set aside and placed at the disposal of the committee to underwrite risks of failure inherent in the adoption of relatively new techniques.

In so far as building research is concerned, a number of techniques such as production of light-weight aggregates, particle boards from coconut husk etc. have been suggested to the Industry, but they have not taken seriously to their production presumably for certain reasons.

In so far as road research is concerned, the Assessment Committee had been working for 3 years now and made recommendations to as many as 8 States for adopting new techniques. Except for some small lengths constructed, no tangible progress has been made. The reason probably is that invariably the States do not have the necessary testing facilities and trained staff to undertake the work. The required facilities are now being organised by the Central Road Research Institute on behalf of the States.

'Roads' being a State subject, the Govt of India and the Planning Commission do not have much of a hold and therefore, it requires frequent follow-up action at a fairly high level so as to get the recommendations of the Central Assessment Committee pushed through.

One possible suggestion with a view to create a climate of healthy competition probably would be, to invite tenders from contractors for the design and construction of the road structure as a whole as is customarily done for bridge structures etc. This would help to create a healthy competitive environments for reducing the cost. This, however, is a very debatable point and it will be instructive to have the views of the experts on this suggestion.

In conclusion, I would like to say that an attempt has been made in this paper to set forth a variety of proposals for consideration by experts in the various specialised fields who have forgathered here today. It is hoped that the points outlined in this paper will serve to direct the discussion purposefully, and that some positive proposals or recommendations will emanate which are susceptible of ready implementation by 'Research' and by 'Industry'.

Acknowledgement

Finally, I would like to take this opportunity to thank Shri C. B. Patel, Director, National Buildings Organisation; Shri T. K. Natarajan, Scientist, Central Road Research Institute; Dr S. K. Chopra, Scientist, Central Building Research Institute; and Dr H. C. Visvesvaraya, Deputy Director, Indian Standards Institution, for their valuable help in the preparation of this paper.

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MEETING OF WORKING GROUP 15

15. Research Utilisation, Cooperation between Research & Industry, Policies on Research & Development

Group 15 of this Get-Together is expected to deal with topics of research utilisation, cooperation between research and industry and policies on research and development. These are topics, not only of general interest, but also impinge on the work in specialised fields of research being considered by other Working Groups. It is not surprising, therefore, that a number of papers touch upon policy matters in specialised fields such as Dr Lahiri's paper on 'Coal Research and Energy Development', Shri Sundaram's paper on 'Manpower' and Dr Bhatacharya's paper on 'Catalysts'. But most of the 58 and odd papers received deal with aspects of social, economic and financial, organisational, planning, personnel, governmental policies, financial control and incentives for promoting industrial research. For purpose of our deliberations, it might be of advantage to take these aspects one by one, summarise the views expressed by different authors, draw conclusions and make recommendations as to what should be done. We will group these aspects as follows:

1. User participation in planning and organisation of industrial research—Concentration of research effort on selected areas
2. Technological gap between industrial research and its utilisation
3. Problems in the development of indigenous know-how; (a) Positive and negative aspects of foreign collaboration; (b) Standardisation, import substitution and spares
4. Cooperative research associations
5. Finances for industrial research
6. Incentives to industry for setting up its own research
7. Personnel training
8. Patent policies
9. Machinery for implementation of recommendations

User Participation in Planning and Organisation of Industrial Research—Concentration of Research Effort on Selected Areas

A number of authors, Shri Y. A. Fazalbhoy, General Radio and Appliances, Bombay; Dr P. C. Mehta, Director, ATIRA, Ahmedabad; Shri C. S. Ramakrishnan, Hindustan Ferodo Ltd, Bombay; Shri S. S. Mehta, Industrial Credit & Investment Corporation of India, Bombay; Shri S. K. Datta, Burn & Co., Howrah; Dr A. N. Kapur, National Research Development Corporation of India, New Delhi; and Shri V. G. Rajadhyaksha, Hindustan Lever Ltd, Bombay, have stressed the need of orienting research to meet the needs of industry. Dr Mukherjee of Sarabhai Chemicals, Baroda, Shri Dubashi of Scientific Economic Foundations and Shri A. C. Ray of Planning Commission have expressed that up till now Industry has not derived much benefit from research in the national laboratories. This point of view is contested by Dr A. N. Kapur and Shri Fazalbhoy. It is, however, generally agreed that utilisation of research would be very much facilitated and research effort more productive if ways and means could be found for close association of technical and managerial personnel from industry with the work of the laboratories. It must be understood that user participation and association of industrial firms with formulation of research programmes is no substitute for the industry setting up of research and development laboratories of their own, nor does it absolve the industrial firms, particularly the larger ones from the responsibility of investing a part of their income and resources in research and development as a means to improve their products and processes. However, since in India the major research effort is so far concentrated in the State sponsored research institutes, for requirements of the industry in the public and private sectors, the immediate solution lies in user participation. Suggestions have been made that this could be achieved by associating panels of scientists and managers from industrial firms in the formulation and execution of research programmes in the laboratories. Shri Rajadhyaksha from Hindustan Lever has also suggested that funds may be freely made available for posting of personnel from research organisations to manufacturing units in industry, to organise a follow-up of their processes taken up by the industry, and to have the impact of industrial requirements on the minds of research scientists. It has been suggested that trade associations of the Industry like the Indian Chemical Manufacturers Association; Automobile Manufacturers Association; Refractories Manufacturers Association; Engineering Association etc. should have a direct association with the working of the laboratories in their field of interest, either by way of representation on the executive councils and scientific advisory committees or by being able to periodically examine the programmes of the laboratories and pose problems of interest to industry. Industrial research in the laboratories would reflect the views and needs of industry much more if industrial firms were participants in the research endeavour of the laboratories.

Financial participation by way of taking over the responsibility (full or partial) for some research projects or research divisions of the laboratory by industrial firms singly or jointly would mean their still closer participation and direct interest in the work of the institutions. The incentives which could be given to the industry for financial participation in research would be discussed later in this paper. We may suggest the following, as specific recommendations which may promote user participation by industries in the framing and execution of research programmes :

(i) Every research institute should have panels of scientific personnel and managers from industries associated with the research programmes. These panels should be responsible for formulation, periodic review and evaluation of the progress of research programmes in the field of their direct interest.

(ii) Where a trade association of industry exists, it should be invited to nominate its representatives on the Council of Administration or Executive Council of the research institute. The Association should also be invited to be an active participant in the finances either by taking over a share of the expenditure or by financing specific research programmes of direct interest to industry.

(iii) Participation by individual firms through sponsored research or contract research should be encouraged.

(iv) Consultancy services by specialists in the research institutes should be available to industrial firms.

Technological Gap between Industrial Research and its Utilisation

Papers from Dr S. K. Subramanian, National Chemical Laboratory, Poona; Shri S. S. Mehta, ICICI; Shri Fazalbhoy, General Radio & Appliances and Dr P.C. Mehta, ATIRA, deal with what should be the organisation pattern for industrial research. Dr Kapur's papers deal with orientation of research programmes to meet the needs of the industry. Besides stressing the close association of industry with research programming these papers stress the importance of formulating industrial research in terms of projects with clearly defined objectives and time schedules. Shri A. C. Ray, Planning Commission, suggests classification in terms of short-term, medium term and long term projects. Dr Subramanian emphasises the need of undertaking surveys and economic feasibility studies and operational data in regard to programmes and careful screening before they are actually put for active experimental research. Shri S. S. Mehta emphasises the role of feasibility studies in research utilisation and project planning at the initial stages, so that only those projects are taken up which have a chance of proving their value in economic returns. Brig. B. M. Chakravarti Director, Electronics & Radar Development Establishment, Bangalore, very pertinently points out that not all the work of the laboratories can or should be in terms of projects. The initial stages of exploration and experimentation where creative approach would bring in greater dividends should not be rigidly time targeted but at later stages where greater investment and concentration of resources is required for industrial upscaling or pilot plant studies or where inter-disciplinary approach is called for by a number of research workers working together, project approach with clearly defined objectives and costing is essential.

Shri Mehta and Nadkarni of ICICI in their paper on 'Development of Indigenous Know-how' have forcefully brought out the point that unless the role of feasibility studies and project engineering apart from process and product know-how is appreciated by the research institutes, the research would not be complete for purposes of utilisation. They have made an analysis of the 'structure' of know-how, defining it in terms of feasibility studies, project engineering, product know-how and process know-how. For the first two types of work, they do not think that this could be taken up by research organisations, due to existing limitations of personnel and finances available. Design bureaus and technical consultancy bureaus should receive encouragement from government for feasibility studies and project engineering. They are also of the opinion that project engineering is one aspect which should be immediately eliminated from technical collaborations with foreign organisations. They have suggested that research institutes should forge close links and liaison with organisations in the public and private sectors offering consultancy and design engineering services. They have also stated that the research organisations could achieve greater impact on the national economy by concentrating efforts on selected areas of importance, chosing a few important problems but taking these to completion, including industrial application of the techniques developed.

Once an area has been located, an action team should be put on the job till full details, administrative, financial and technical, have been worked out and the problem resolved from all angles. These action teams can consist of staff from national laboratories and technical personnel from industry jointly. Government should take fiscal measures and give incentives for participation in such research projects by industry. Shri M. M. Suri, Director, Central Mechanical Engineering Research Institute, Durgapur, has stressed that a proper identification of the problems of industry and their definition would be possible only if the industries set up their own research and development cells who in turn should collaborate with the national laboratories. According to him, the engineering industry is not working beyond 25-30 per cent of its installed capacity and the factors which are making it work below capacity should be resolved in technical terms. He considers that for self-generating technological advancement of the industry, the national laboratories alone cannot possibly fill the gap. He strongly advocates the measures being taken by the industry to set up its own research institutes either singly or jointly. This point has also been stressed in a different manner by Dr A. N. Kapur of NRDC, Dr K. Venkataraman, Director, National Chemical Laboratory and Shri A. C. Ray, Planning Commission who have suggested that appropriate conditions should be imposed on licensing of industries. Industrial firms beyond a certain size particularly those with foreign collaboration must compulsorily setup research and development units for which they may be given due tax concessions and other financial incentives.

Summing up, our recommendations may be as follows:

(i) The national laboratories must have survey and planning and operational research cells which should screen research projects from economic and technological aspects taking into consideration data on imports, exports, consumption, prices and markets before experimental research is undertaken.

(ii) Industrial research should be done on project basis with clearly defined basis and time targets. It may not be possible or desirable that the entire research programme of the laboratories is in terms of projects but industrial research which has come to the stage of involving concentration of resources and efforts, or inter-disciplinary planning, should be formulated on project basis.

(iii) The resources of the laboratories must not be spread over too wide areas. They must be concentrated on selected projects of direct interest to industry, which must be pursued to the stage of completion.

(iv) Once a project has reached a certain stage, action teams of technical personnel from research laboratories and user industries must examine and execute all studies of the project from feasibility studies down to completion and utilisation. For this free movement of technical personnel between research and industry and financial support and incentives to industry should be given.

(v) Large industrial firms and those with foreign collaboration must set up research and development organisations of their own and this should be a compulsory condition in their licence.

Problems in the Development of Indigenous Know-how

Dr S.K. Mukherjee of Sarabhai Chemicals and Shri J. C. Kapur of Airconditioning Corporation, Shri S. S. Mehta, ICICI and Shri M. M.

Suri, Director, CMERI, have brought out the urgent need of developing self-dependence in respect of know-how and technology in the country. It has been done in certain cases but it is commonly agreed that far more requires to be done, since the predominant control of technology in India still rests with foreign firms. Shri Fazalbhoy and Shri Mehta say that dependence upon foreign know-how can be extremely dangerous particularly in times of emergency. Shri Mehta emphasises that achievement of 'a satisfactory level of indigenous know-how is bound to take some time and it is all the more necessary to take early steps'. He says that a price will have to be paid for this attainment. There will be mistakes made. There will be wastage of time and there will be disappointments but this will be a small price for providing a future base for our future industrial growth. Shri Mehta feels that it will be justifiable and even advantageous to take recourse to foreign technical collaboration during initial periods but this advantage is lost through repeating it second and third time and the failure to develop our own indigenous know-how. Shri G. S. Chowdhury, Director, Regional Research Laboratory, Bhubaneshwar, makes a refreshing analysis of the major reasons why industry prefers foreign know-how to Indian know-how and clearly brings out that the conditions for the utilisation of indigenous know-how are far less favourable to the financier compared to the ease of setting up an industry with foreign collaboration. The financier is exposed to the triple disadvantages of (i) accepting Indian know-how with less commercial goodwill, (ii) combined with the procedures for industrial licensing with Indian know-how being more cumbersome and difficult, and (iii) the reluctance of financing organisations, banks etc. to underwrite the equity issue if indigenous know-how is used.

He has outlined the following measures to affect this disadvantage if Indian research is to be accepted by the Indian financier.

(i) The Government of India should guarantee the minimum required foreign exchange for import of equipment, instrumentation, raw materials, etc. based on a process leased by the CSIR to industry.

(ii) To attract the common man to take part in the capital subscription, the public sector institutions such as LIC, ICICI, the various state finance corporations, etc. may be encouraged to subscribe to part of the equity capital and also to underwrite a part of the equity issue. The procedure will naturally infuse confidence on the subscribing public, and will contribute to the success of the project. This procedure may be necessary for a limited period till such time the public gain confidence in new ventures based on processes released by CSIR to industry. With such facilities available for capital contribution, the new financier will also come forward and will be prepared to take chances on the processes developed indigenously.

(iii) The CSIR should on its part give an undertaking that based on certain cost of raw materials and the process know-how, the ultimate cost of the product will be well within certain permissible limits, and if there is any variation in the above cost, thereby affecting the marketability of the product, the CSIR may compensate for such failures in a suitable manner agreed to mutually.

(iv) A separate fund to cover such risks may be constituted and kept under the control of a high power authority of the CSIR.

Shri Chowdhury's observations are of the greatest importance because conditions for licensing, import of essential spares, components and raw materials, financial security and risk coverage must be made easier for industries to be set up with Indian know-how. If indigenous know-how is to grow and develop at a national scale the balance of advantage must be tilted in favour of indigenous know-how. Direct and powerful incentives as advocated by Shri Chowdhury must be provided to change the climate and greater restrictions on indiscriminate foreign collaboration introduced.

The above authors have also pointed out the extremely dangerous policy of the country continuing to link its future development to collaborations from abroad, which would have the effect of keeping the level of India technology always backward as compared to their parent firms. It need not be denied that the speed with which India has grown industrially would not have been achieved without foreign technical and financial assistance. At the same time, the foreign know-how has not been an unmixed blessing. It has brought in its wake disadvantages and problems which plague the future development of indigenous know-how, technology and industry itself. These problems have forcefully come to light under the restrictions imposed on imports and the paucity of foreign exchange. Some of these are described below.

(i) Multiplicity of collaborations for the same item has introduced in the country standard specifications of machinery, equipment components, raw materials belonging to many countries. An industrial product of comparable quality manufactured by collaboration from Germany, Japan, USA, UK, Yugoslavia, USSR, Czechoslovakia, in this country requires standards to be maintained in accordance with the imported know-how of these countries. Thus the industry is handicapped by multiplicity of standards.

(ii) While for a number of assembly industries, common spares may be used for economic production, the spares and components should be mass produced. Multiplicity of collaboration and designs have created problems in regard to supply of spares which cannot be mass produced because of different specifications. Production of these on a limited scale would not be economic. This situation has created problems of continued dependence on imports of spares and components to keep the wheels of industry going.

(iii) Since the process and design of equipment of machinery supplied by collaborators is linked with raw materials, the industry has continued importing these raw materials. This has resulted in a set-back to research and utilisation of indigenous raw materials. The problems which beset the automobile, radio components, steels and several other industries are borne out of their being dependent upon different collaborations.

Some of these problems have been touched upon by Dr P. K Srivastava, Senior Research Fellow, who has forcefully brought out the compulsion exercised by foreign collaborators in respect of supply of raw materials. A button manufacturing concern in Saurashtra had to close since it was importing Japanese plastic sheets from its collaborators. The nonutilisation and under-utilisation of production capacity of the machinery in our country, due to non-supply or under supply of some important items by the foreign collaborator has occurred in some cases. As per terms of their aggreements, the Indian firms cannot purchase raw materials from any other source. He has quoted the case of a catalyst manufacturer in America who is its sole supplier to sulphuric acid plants and can slow down or hold up production by delaying the catalyst supply. Cases have also been cited of electric cables and electric coiling industries for the supply of raw materials for which the foreign collaborator assumes responsibility for supply and Indian firms indulge in either partial manufacture of assembly.

Dr Srivastava has also made a forceful plea for introducing some sort of discrimination in permitting collaborations for articles which are of no direct economic or industrial importance to the country. Collaborations for ink, ready-made shirts, ball point pencil pens, sewing needles, leather footwear, measuring tapes, water filters, ice cream, bicycle dynamo lamps, umbrella ribs, table tennis balls, wooden furniture, timepieces, wearing apparel are cases where indigenous know-how could have caught up even without foreign collaboration. He argues that collaboration should be permitted only for those industries where it is indispensable.

Shri Gurucharan Singh of the Indian Standards Institution has presented a valuable paper in regard to the role of standardisation in the national emergency and its importance in import substitution, conservation of scarce materials and scope for industrial research. India was importing 1500 varieties of alloy steel which through standardisation have been reduced to 60. Standardisation activity in respect of structurals has resulted in substantial saving in the use of steel. Standardisation of timbers has resulted in saving of imports and replacement of wooden separators in batteries and cooling towers by indigenous woods. It is necessary that standards for various products such as cables, door hinges, utensils, screws and bolts etc. be altered to meet with the requirements of indigenous materials of construction. Standardisation can, while prescribing standards take into account availability of Indian materials and eliminate unnecessary imports. Even if the imports have to be made, it should be insisted that they should be in accordance with the Indian Standards and the foreign manufacturers should supply materials to conform with National Standard Specifications of India, in turn be linked up with the indigenous know-how and technological developments. Since the standards are drawn up with the help of committees consisting of representatives of industry, consumers and users, technologists and scientists from research institutions, their common acceptance would be a great factor in introducing indigenous products, raw materials and know-how. We feel that the role and potentialities of standardisation in creating self-dependence have not been fully utilised. The exaggerated goodwill enjoyed by foreign trade names would to a great extent be shared by the Indian products if the standards laid down are observed. Shri Singh has also touched upon the problem of standardisation of spares and has pointed out that the annual import figure is of the order of Rs 2,000-3,000 millions. He has advocated that if the steel production, power generation, oil exploration and refining, machine building and other industries could take to Indian standards, the problem of spares would be greatly alleviated if not altogether solved.

Notwithstanding the severe impediments placed in the way of development of indigenous know-how by these indirect aspects of foreign collaboration, valuable work on development of indigenous know-how has been reported by Shri S. K. Datta of Burn & Co. and Shri M. M. Suri, Director, CMERI. Research work undertaken by Burn & Co. who have had the foresight of having design and drawing offices as well as physical and chemical laboratories although chiefly rendering service to manufacturing and quality control have led to significant results. Shri Datta has reported how imported steel was replaced by them by high carbon alloy steel, improvement achieved in pressing work by innovation described as collapsible punching die, replacement of non-ferrous bearing shells in rolling stock by spheroidal graphite iron castings and elimination of the use of CO_2 cores by adopting hollow cores. He has also pointed to the use of Indian bentonite substituting bentonite imported from America and UK. One would wish that research and development work within the industry was a little better publicised and made use of by others. Shri Datta has suggested cooperative research as a possible solution. If the firms which have research and development units of their own could consider publicising part of their achievements of direct interest and usage by other firms against suitable terms, it may result in accelerated overall development of the industry in their field.

Shri Suri has given examples of how Japanese who were sneered at for their copying talent by the West have now earned the respect of countries like America and UK and Germany whose markets are flooded with Japanese goods. Shri Suri has pointed out that the Japanese' miracle is due entirely to advanced scientific and technological research in that country and by the wise policies and methods adopted. Japan has a national policy which does not permit of control of technology by foreign interests. Ministry of International Trade and Industry carefully screens all collaborations and permits only those which advance indigenous technology. Even these are on outright purchase of know-how and design.

Shri Suri has pointed to the need and desirability of having a national policy on the use of science and technology. He says that what is grossly lacking in India is a science-oriented policy. He has given the examples of cable making machinery developed by the Institute in close collaboration with the Hindustan Cables Ltd of which the imports during the Fourth Five-Year Plan were contemplated at Rs 24 crores in foreign exchange. Even with the help of relatively inexperienced scientists and engineers of the institute but with close cooperation of the industry, complete designs were developed with 98 per cent indigenous content with the help of engineering firms like Kumardhobi and McNally Bird. The prototype of these machines are already working and global tenders worth Rs 1.76 crores of machines have been tendered. He has given another striking example of steel structures developed by the CMERI resulting in economy of over 30 per cent of steel over the conventional design. The reduction of investment on completed structures due to improved designs resulting in savings is valued at a minimum of Rs 100 crores.

In dealing with the science policies some authors have brought to bear the fact that the machinery for decision making in regard to know-how, setting up of industries requires to be technologically oriented. Dr G. P. Chatterjee of Hindustan Steel Ltd, Shri Fazalbhoy of General Radio and Appliances, and Shri Dutta of Burn & Co. and a number of others have pointed out that unless the decisions are taken by persons who are themselves technologically trained, the present state of affairs is likely to continue. A stage has come in our development where the policies and decision-taking level should rest in technical hands. This may involve orientation of the decision making machinery but for the development of self-depending indigenous know-how, this may be inescapable.

Cooperative Research Associations

Shri C. S. Ramakrishnan of Hindustan Ferodo Ltd, Shri S. K. Datta of Burn & Co, Dr A. N. Kapur of NRDC, Shri Fazalbhoy of General

Radio and Appliances, Dr P. C. Mehta of ATIRA have advocated bringing industry into active participation with research efforts. They have agreed with the Third Reviewing Committee of the CSIR who have expressed the view that one of the most useful mechanism for this purpose would be the cooperative research associations. A large sector of industries having problems in common but not having the financial and technological resources for the setting up of research and development units of their own could be assisted in setting up of research institutes. The advantages of this type of institutes have been listed. It has also been suggested that such institutes need not feel shy of taking up problems belonging to individual units of industry, the results of such research must be kept secret and passed on exclusively to the sponsoring industry. It is not always essential that the cooperative research associations of industry must set up research laboratories of their own. They can set up Information Centres and research and development groups based on their permanent staff who can be given the responsibility of identifying the problems of industry, sponsoring them and ensuring their follow-up, subsequent dissemination and communication of the results to their group of industries.

Finances for Industrial Research

Dr P. C. Mehta of ATIRA, Shri S. K. Datta of Burn & Co., Shri K. Manivannan of Shri Ram Institute for Industrial Research and Shri M. M. Suri of CMERI have all discussed aspects of funds for research. A very interesting suggestion of S. B. Sen of Aligarh has been made. He suggests that the total research effort in the country whether in State sponsored research institutes or in the laboratories of the industries, financial support should be from a National Research Fund. This fund should be built up on the basis of levy or contributions from the industries and donations by the government. Allocation of resources to different institutions must be on the basis of national priorities for different types of research. The suggestion certainly merits serious consideration because participation by industry in such a venture would bring them as partners in national research and not only as disinterested critics alone. Shri G. S. Chowdhury, Director, Regional Research Laboratory, Bhubaneshwar has spoken of financial arrangements for exploitation of results of research while Shri Suri and Shri Fazalbhoy have made a categorical plea for a larger scale investment in scientific and technological research. Shri Suri has made a plea of minimum investment of Rs 700-800 crores in research and development during the Fourth Five-Year Plan. Dr M. S. Iyengar, Director, Regional Research Laboratory, Jorhat, in his paper has pointed out that our country has yet to realise the vital link between research and development and self-dependence in know-how. He has in an illustrated paper drawn on the experience in Great Britain which during the war oriented 55 per cent of its budget to support the war economy from 14 per cent in the pre-war days. He has also pointed out that the research and development budget increased from 6 to 20 per cent.

While every effort must be made to relate and integrate research and development with the tasks of nation building and industrial development, the basic role of scientific and industrial research as promoter and sustainer of industrial progress and economic development must be clearly recognised. Financial support to research must be assured.

Incentives to Industry for setting up its Own Research

Dr K. Venkataraman, Director, National Chemical Laboratory and Shri M. M. Suri, Director, CMERI and others have argued that for real industrial progress, research and development efforts by the industry itself will have to be made. Drawing on examples of Japan, Germany and other advanced countries, Dr Venkataraman proves that more research is done by industry itself in Japan than is carried out by government sponsored institutes. The state of affairs in Germany, England and USA is not different. Shri Chowdhury advocates incentives being given by way of tax reduction, risk capital, subsidies for approved projects. Dr Kapur and Dr Mukherjee quote the examples of Canada where Scientific Research Council supports financially research in industry the results of which belong to industry itself and advocate subsidies by the government to industrial firms undertaking research and development effort. Suggestions have also been made that extra profits earned by industry by the use of its own innovations should be retained by the industry without tax for limited periods. Dr Kapur makes a comparison of incentives provided to industry elsewhere and in India and concludes that incentives to industry compare favourably with those available elsewhere but have not been utilised fully for other reasons. It is agreed by most of the authors that industry must be induced by giving incentives for research and development effort, but it has also been suggested that a certain degree of compulsion could be introduced in matters of preference for allotment of raw materials, licensing and other facilities for industries developing their own know-how or undertaking research and development work.

Personnel Training

Training of technical personnel is the subject of the papers of Shri K. N. Sundaram of the Institute of Applied Manpower Research, Shri K. Ray and Dr B. K. Nayar of National Register of Scientific & Technical Personnel of the CSIR. It has been pointed out that in technologically advanced countries, the number of engineers and technologists is at least 4 times the number of scientists. Although India ranks next to America and Russia as having the largest number of science graduates, the proportion of engineers and technologists is in the reverse order. This is one of the most serious handicaps for industrial development. The personnel policies for training must cater to greater number of technologists and engineers than pure science graduates. The three authors have stressed the need for training of research and design manpower and Ray has advocated a change in the planning of manpower policies. Ray has also advocated a mobility of personnel between training institutions and industry, bringing scientists and technicians in research and industry closer to each other, and finding means of permitting technical personnel in non-scientific employment for shifting to jobs of a technical nature. Shri Datta has advocated a vigorous policy of talent search at a younger level on the lines practised in USA where industrial firms send out members of their personnel departments to look out for talented younger people who are absorbed directly into the industry. It has been pointed out by Dr Venkataraman that while in India a person after his Ph.D. looks to Scientists' Pool or a Senior Research Fellowship, in America he enters the industry without loss of time and his talent to the country.

In another paper Garg and Sharma from the Department of Mechanical Engineering, Indian Institute of Technology, New Delhi, have drawn attention to the unsatisfactory state of affairs of undergraduate and postgraduate teaching even in the Institutes of Technology. Heavy teaching load of 18-19 hours per week as compared to 6-7 hours in UK, inadequate research facilities result in students being turned out with degrees, who have no desire or initiative for creative work or research. Undergraduates have no opportunities for design development or creative skills. They have advocated that technical and engineering institutes should be screened and dead wood removed. Bureaucratic administrative procedures which result in delay of essential purchase of equipment, apparatus, sometimes lasting over a year or more need urgent change. They have pointed to the lack of communication between IIT, Engineering Colleges and industries which results in giving the undergraduate and graduate less practical and more of academic outlook.

Patent Policies

Shri Vargese from Shri Ram Institute for Industrial Research and Shri R. B. Pai from CSIR have drawn attention to the patent position. Shri Vargese has advocated that granting of patents to foreign firms should be restricted and patents which are against national interests should not be allowed and greater use of compulsory licensing should be made while Shri Pai has advocated that the foreign exchange could be earned by indigenous patenting firms undertaking patenting work on behalf of foreign patentees. He is against the policy of allowing foreign firms of patent attorneys in the country who do not earn any foreign exchange but export their profits and earnings.

Surprisingly, there have been no papers on the patent policies as such but we feel that in a country of which 90 per cent of the patents are owned by foreign interests it needs looking closely into its patenting policies. The very disproportionate number in favour of foreign patents points to the fact that industrial research and development in this country is dominated by protection to patents in favour of foreign interests. It would do this country a great deal of good if like Japan, Italy and some other countries, no patents were permitted for a period of 10 years. It must be however understood that patent policy is a subject by itself and could hardly be covered in a paper for a Working Group meeting of this type. It would be pertinent to point to the preponderance of foreign patent control over Indian know-how. No country struggling to develop its own know-how could be happy over the state of affairs.

Machinery for Implementation and Follow-up

Shri D. N. Shroff has advocated the setting up of a machinery to follow the recommendations of the Get-Together. He has suggested that the CSIR should organise a follow-up of recommendations and evaluate its results on the development of the indigenous know-how and self-dependence. Elsewhere Shri Mehta has advocated the setting up of action teams for research projects. The setting up of a machinery preferably at a national level which should ensure the action on the implementation of the various recommendations and the executive measures required to be taken by different government departments should be clearly defined. A number of measures of short-term or long-term nature which would result in saving of foreign exchange, development of substitutes or utilisation of indigenous know-how would emerge out of the deliberations of other Working Groups. The task of putting these into practice must be made the responsibility of an inter-departmental committee preferably functioning under the Cabinet with the association of responsible agencies in the field of science and industry.

Concluding Session

(December 21, 1965)

Address

SHRI M. C. CHAGLA

Chairman

While listening to these reports and speeches, I have been reminded of my good old days when as a judge I used to hear such lengthy reports, statements and arguments in a Jury.

I am happy to note that strong support was expressed in the Working Groups to the suggestion that 5 per cent of the turnover of major industries and also of some medium units be contributed to the scientific research, and this amount should be free of income-tax. I shall surely bring this suggestion to the notice of my friend, the Finance Minister, who I am sure, will consider it favourably.

There are few matters which I wish refer and which have attracted my special attention. I do not want to mention individual suggestions which have been made by the respective group leaders but I must say that some of the suggestions made by the conveners of the Working Groups have appealed to me. And, in that, this Get-Together has been an ideal success.

It would be waste of time, energy and a great deal of futile effort on our part if we just disperse after hearing the papers presented by the individuals assembled here.

It is, therefore, essential that we should 'follow-up' action on the decisions that we have arrived at after a great deal of discussions and the conclusions which we have reached, in this two-day conference. In this context, one particular suggestion appealed to me and that is the establishment of a Technical Advisory Body for industrialists. Here, we are all industrialists and scientists and I think it would be a very good suggestion if we have a Technical Advisory Body functioning to assist us.

Then, my friend, Shri Suri has mentioned the 'time targets' for Research Projects. I do hope people must have time targets for carrying out the jobs entrusted to them. It is not difficult to lay time targets but it is essential for us to fix time limit in order to produce a plan for complete self-reliance in as short a time as possible. It is an healthy procedure and it helps to accomplish our goals within the desired period.

Last year, when I was desired to submit the Report of the Education Commission to the Government of India, I also fixed a time target for the submission of my Report. I desired that the Report should be ready and submitted to me on March 21, 1964 and I was told that the Report would be submitted to me within that time target. I am happy to tell you that the Report was exactly submitted to me on March 21, 1964 which I think was a great achievement.

I do not expect certain decisions to be carried out in the next few weeks, but it is good to fix time targets so that you may be able to watch over the progress of your project. When a particular project is assigned to a particular person he may be held responsible for carrying out the duties within the stipulated time.

It is obvious that under the impact of economic crisis facing the country and the drying up of the resources of foreign exchange with practically no aid available from sources abroad, the scientists and the industrialists in the country, whether in the research laboratories or in industries, have thespecial challenging task of keeping the wheels of the Indian Industry going without imported raw materials. As such, all energies must be bent towards reducing this dependence. The time has come when the inertia engendered by undue reliance on foreign help has to be overcome and brushed aside. 'Self-reliance' should be the slogan of the day.

Another point which I would like to stress is that there should be close collaboration between the National Laboratories and the Industries for harnessing science. We also want collaboration with the Universities and with all our Technical Institutions that exist in the country.

When I was Ambassador in the United States of America, I went to see a factory; there I saw a small car being assembled. I thought that every part of this small vehicle was manufactured there itself. But I was told that many of the small parts of the vehicle were fabricated by the various small scale industries elsewhere except the few important parts which were manufactured there and which were essential to complete the car and put it on the road finally.

This is worth remembering. The small scale industries in India should remember that there are many small things which can be fabricated economically by the small scale industries for the use of the big industries and thus they can help in the economic development and safeguarding the interests of the country.

I was also impressed by the suggestion made for carrying out a survey of the Minerals Wealth of our country. There is hardly anything that our country does not possess. We have water, iron, coal and other minerals but I think we are not ourselves conscious of the wealth we possess. Our mineral wealth, as you know, has not been adequately processed. I think the time has come when we should carry out a proper survey of all our mineral resources in the country in order to find out what Mineral Wealth is available with us to assist our industry.

I was also impressed by the suggestion made by Shri Suri that we should have a Directory of technological information. I think the compilation of such a Technical Directory would be of immense help and guidance to our industries all over the country. Such a Directory will guide, advise and indicate to the industry the various facilities available in the research laboratories, institutions and universities in the country to carry out their particular research projects.

The suggestion of the industry to set apart 5 per cent of their total turnover to scientific research is indeed laudable. Even if the industry did not come forward with such a generous suggestion and the State had to think of the ways and means of statutory or mandatory measures to persuade the industry to such a contribution, the State perhaps would have declared automatically such an investment on scientific research, free of income-tax. I therefore, do not see much difficulty in getting this participation income-tax free.

I must thank you for the keen interest which you evinced and the trouble which you took in coming over here and making this function a grand success. Your mass participation is indeed the proof of your keen interest in the promotion and application of science in the country.

Before I leave you, I want to assure you that your recommendations based on your practical and pooled knowledge will not merely remain on paper. Every recommendation worth-considering and worth-implementing will be considered and implemented successfully as soon as possible, within six months or one year.

Thank you.

Dr S. HUSAIN ZAHEER

I have only a few words to say and that is mainly to the industrialists and the scientists for their taking the trouble of coming over here. I do hope that they will agree with me that it has been worthwhile.

Now, the points which I would like to make are:

1. We hope to publish some of the selected papers, key papers and the recommendations of the respective Working Groups either groupwise or in separate volumes and the same would be available to the members for wide distribution.

2. I hope I shall be able to call a meeting of the Conveners and Chairmen of the Working Groups to recommend distinctly what further action is required primarily on what the Vice-President, CSIR, has suggested in addition to the CSIR having a series of Research Committees in various Disciplines of Science, like Chemical Research Committee, Physical Research Committee, Engineering Research Committee etc. They propose to have a Technical Advisory Committee for major groups of research and industry. I think we will take immediate steps to form such a committee after the meeting of the Conveners and Chairmen had taken place. After the formation of the Technical Advisory Committee it will start functioning immediately and we see that the follow-up action on the recommendation of the Working Groups is taken.

3. The other suggestion which the Vice-President has made was in regard to the formation of Directory of Technical Information. Actually the INSDOC was entrusted with the task of preparing such a Directory about 17 years ago. But somehow or the other, this part of the work has not been done. It is, therefore, necessary to re-organise INSDOC in a manner so that it should be able to compile such a Technical Information Directory for the use of the industry. Information on this aspect is not available in the country or if it is available, it is in scattered form. It is desirable to collect technical information and consolidate it in one volume.

As I have mentioned to you earlier I have covered most of the important points and I repeat them.

1. The publication of the selected papers, key papers and the reports of the Working Groups.

2. Calling a meeting in the very near future of the Conveners and Chairmen of the Working Groups to discuss further what action should be taken for implementation of some of their recommendations. I still feel that some recommendations have to be given in a more concrete shape. As suggested by the Vice-President, CSIR, we will have time target for each research project, with project leaders and who will be responsible for the implementation of the projects within the stipulated time.

3. The formation of the Technical Advisory Body of Research and Industry for each major group of industry by CSIR will follow soon after this meeting of the Conveners and Chairmen had taken place.

4. The work relating to the publication of the Directory of Technical Information will be taken up by the INSDOC after it has been re-organised.

Thank you.

Shri BALDEV SINGH

It is my pleasure to thank the Departments of Defence, Railways, DGTD, Ministry of Industry and other Organisations, as well as the scientists and industrialists drawn from various disciplines of science and industry in the country for their wholehearted participation in the two-day conference and making it a grand success.

We have more than 400 papers contributed by the Working Groups, which I think is, indeed, a good achievement of this Conference. We hope, something fruitful will come out of it.

Thank you.

Appendices

APPENDIX 1

Papers Presented at the Get-Together of Research and Industry

(*Papers marked by asterisks will be published in subsequent volumes*)

WORKING GROUP 1

Electronics, Instruments, Radio, Television, Public Address Systems and other Appliances

*1.1 Some problems relating to electronic components by G. R. S. Rao, National Ecko Radio & Engineering Co. Ltd, Bombay.

1.2 Indigenous manufacture of optical instruments by Ram Prasad, Central Scientific Instruments Organisation, Chandigarh

1.3 Design of thermistorised radiometer and instrument of photoelectric type for measurement of whiteness by V. H. Vaidya, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*1.4 Industrial instruments and components and possibility of their manufacture in India by S. P. Paul, Durgapur Steel Plant, Durgapur.

*1.5 Indigenous manufacture of electronic instruments by T. G. Krishnamurthy, Associated Electronic Engineers, Bangalore.

*1.6 An outline of the plan for self-sufficiency in electronic equipment by J. S. Chatterjee, Dept of Telecommunication Engineering, Jadavpur University, Calcutta.

1.7 Industrial electronic and control instrumentation by A. Pande, Shri Ram Institute for Industrial Research, Delhi.

*1.8 Geophysical instrumentation by D. Gupta Sharma, National Geophysical Research Institute, Hyderabad.

*1.9 Importance of instrumentation in river valley projects by V.K. Sondhi, Deputy Director, Central Water & Power Commission, New Delhi.

*1.10 Instrumentation for vibration studies by Prof. Jaikrishna & A. R. Chandrasekhara, School of Research & Training in Earthquake Engineering, University of Roorkee, Roorkee.

*1.11 Instruments for measurements and control in textiles and related fields by T. Radhakrishnan, Ahmedabad Textile Industry's Research Association, Ahmedabad.

1.12 Lead sulphide infrared detectors by C. V. Suryana, Central Electrochemical Research Institute, Karaikudi.

1.13 Sharpening of razor blades by M. A. V. Devanathan, V. K. Venkatesam & S. Sarangapani, Central Electrochemical Research Institute, Karaikudi.

1.14 Some factors on the development of electronics in India by U. H. Narayanan, Central Electrochemical Research Institute, Karaikudi.

*1.15 Applied optics at the Indian Institute of Technology, Delhi by P. K. Katti, Physics Department, Indian Institute of Technology, Hauzkhas, New Delhi.

*1.16 Development of microscope optics industry in India by Dr P. S. Gill & J. Prasad, Central Scientific Instruments Organisation, Chandigarh.

1.17 Some silicon based industries by G. Suryan, Dept of Physics, Indian Institute of Sciences, Bangalore.

*1.18 Development centres for instruments by All India Instrument Manufacturers and Dealers Association, Bombay.

1.19 Fabrication of radiation safety equipment at INMAS by R. K. Bhattacharyya, M. L. Bedi & N. A. Nayak, Institute of Nuclear Medicine & Allied Sciences, Delhi.

1.20 Development of high Megohm resistors by S. Srinivasan, U. Venkateswarlu & K. G. Menon, Electronics Division, Atomic Energy Establishment Trombay, Bombay.

1.21 Availability of electronic components and the pace of electronic design in India in the field of instrumentation for geophysical exploration for oil and gas by M. A. Ganapathy, K. Aravamudhan & E. Pastalka, Oil & Natural Gas Commission, New Delhi.

1.22 Problems in producing indigenous servo-components by S. Mukherjee, Electronics Division, Atomic Energy Establishment Trombay, Bombay.

1.23 Milligraf, a self-balancing potentiometric dc. millivolt recorder by K. R. Laxminarayan & C. L. Pande, Atomic Energy Establishment Trombay, Bombay.

*1.24 Fruitful industrial research in electronics by T. R. Raman, Atomic Energy Establishment Trombay, Bombay.

1.25 Industry and medical science by T. G. Krishnamurthy, Associated Electronic Engineers, Bangalore.

*1.26 Development of maximum utilisation of resources for instrument industry by B. D. Toshniwal, Toshniwal Bros Pvt Ltd, Bombay.

*1.27 Some aspects of research and development in radio industry in India today by J. Wijsma, Philips India Ltd, New Delhi.

WORKING GROUP 2

Industrial Organic Chemicals, Biochemicals, Dyes and Intermediates Rubber, Resins, Adhesives, Plastics, Paints, Varnishes, Surface Coatings

2.1 Comments from Dr A. Lahiri, Central Fuel Research Institute, Jealgora.

2.2 Rubber, adhesives and plastics—Indigenous know-how and possible industrial research programme by K. J. Balakrishna, Defence Research Laboratory (M), Gwalior.

2.3 Comments from Manager, Res Chemol Private Ltd, Calcutta.

2.4 Comments from N. K. Bhattacharya, Indian Institute of Technology, Kharagpur.

2.5 Raw materials for synthetic musks and perfumery compounds by S. A. Hakim, A. Maschmeijer Jr (India) Pvt. Ltd, Madras.

2.6 Comments from Rubber Board, Kottayam.

2.7 Gelatine and its role in photographic emulsions by S. K. Jain, Hindustan Photo Films Manufacturing Co. Ltd, Ootakamand.

2.8 Comments from Dr R. T. Thampy, Shri Ram Institute for Industrial Research, Delhi.

2.9 Rubber base compounds as substitute for tin-lead solder in the manufacture of containers by R. Dutta, Research and Development Manager, Eyre Smelting Pvt. Ltd, Calcutta.

*2.10 Research and development in dyestuff intermediates by B. V. Shah, Atul Products, Atul.

2.11 Fine chemicals project at the National Chemical Laboratory and its role in the development of research and industry by P. K. Bhattacharyya, V. P. Fernandez & N. L. Dutta, National Chemical Laboratory, Poona.

2.12 Possibilities for establishing electro-organic industry in India by H. V. K. Udupa, Central Electrochemical Research Institute, Karaikudi.

2.13 Coumarone-indene resin from crude benzole and coal-tar heavy naphta by S. K. Bose & N. G. Basak, Central Fuel Research Institute, Jealgora.

2.14 Conversion of higher homologues of phenols to phenols and cresols by N. G. Basak, Central Fuel Research Institute, Jealgora.

2.15 Anion exchange resin from tar acids, phenols, cresols and the like by P. N. Mukerjee & A. Lahiri, Central Fuel Research Institute, Jealgora.

2.16 Phthalic anhydride from tar oils by A. N. Basu, Central Fuel Research Institute, Jealgora.

2.17 Studies on preparation and uses of carbion by P. K. Banerjee, Central Fuel Research Institute, Jealgora.

2.18 Thermosetting resin from coal-tar fractions by C. S. B. Nair, A. N. Basu & A. Lahiri, Central Fuel Research Institute, Jealgora.

2.19 Studies on the oxidation of cumene to alpha-cumyhydro-peroxide by N. G. Basak & A. Lahiri, Central Fuel Research Institute, Jealgora.

2.20 Oxidation of anthracene to anthraquinone by C.S.B. Nair, A.N. Basu & A. Lahiri, Central Fuel Research Institute, Jealgora.

2.21 Plastics as substitute for metals by M. Krishnan & R. T. Thampy, Shri Ram Institute for Industrial Research, Delhi.

2.22 Selection of a process for the manufacture of vinyl chloride in India by R. K. Bhatnagar, Shri Ram Institute for Industrial Research, Delhi.

2.23 Aluminium-zinc oxide composite primers by Regional Research Laboratory, Hyderabad.

2.24 Hydrogenated castor oil by Regional Research Laboratory, Hyderabad.

2.25 Surface coatings from cashewnut shell liquid by Regional Research Laboratory, Hyderabad.

2.26 Lac and its products as import substitutes and industrial raw material by M/s Shellac Export Promotion Council, Calcutta.

2.27 Catalytic hydrogenation of benzene to cyclohexane by E. R. Saxena & M. K. Zaman Khan, Regional Research Laboratory, Hyderabad.

2.28 Hydrazine sulphate and hydrate by E. R. Saxena, Regional Research Laboratory, Hyderabad.

2.29 Role of organic chemical industry in import substitution by G. C. Motwani, Union Carbide (India) Ltd, Industrial Products Division, Calcutta.

2.30 Import substitution in manufacture of organic fertilisers by M. V. Bopardikar, Member of Export Panel of the World Health Organisation Environmental Sanitation, Geneva & J.M. Dave, Central Public Health Engineering Research Institute, Nagpur.

2.31 Microbes and industry by S. R. Vyas, Dept of Microbiology, Punjab Agricultural University, Hissar.

*2.32 Paints' raw materials by E. L. Armitage, Imperial Chemical Industries, Calcutta.

*2.33 Dyestuff industry by S. J. Shah, Aniline Dyestuffs & Pharmaceuticals Pvt. Ltd, Bombay.

WORKING GROUP 3

Inorganic and Heavy Chemicals, Fertilisers, Cement, Marine Chemicals

3.1 Comments from A. Lahiri, Central Fuel Research Institute, Jealgora.

3.2 Neyveli Lignite Corporation Ltd, Fertiliser Plant by Chairman, Neyveli Lignite Corporation Ltd, Neyveli.

3.3 Export promotion by waste gas utilisation by V. A. Altekar, Dept of Chemical Technology, Bombay.

*3.4 Chemicals from sea and inland brines by D. S. Datar, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*3.5 Ion exchange: A new tool for recovering potassium fertiliser and iodine by D. R. Baxi & D. S. Datar, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

3.6 Salt for industry and export by G. C. Jain & R. K. Sapre, Central Salt & Marine Chemicals Research Institute Bhavnagar.

*3.7 Manufacture of potassium fertilisers utilising sea and inland bitterns by D.S. Datar, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*3.8 Economics of alkali production by B. C. Jain, Birla Brothers Pvt Ltd, Bombay.

*3.9 Indigenous production of some important inorganic electrochemicals by S. Sampath, Central Electrochemical Research Institute, Karaikudi.

3.10 Luminescent phosphors by C. V. Suryanarayana, Central Electrochemical Research Institute, Karaikudi.

*3.11 Hydrochloric acid in the pickling of steel economic evaluation by S. K. Karamchandani & V. R. S. Arni, Union Carbide (India) Ltd, Calcutta.

3.12 Extraction of coal with anthracene oil by A. N. Basu, N. G. Basak & A. Lahiri, Central Fuel Research Institute, Jealgora.

*3.13 Production of active carbon in fluidised bed by N. G. Basak & S. Banerjee, Central Fuel Research Institute, Jealgora.

3.14 Fertilisers from coal by P. N. Mukerjee & A. Lahiri, Central Fuel Research Institute, Jealgora.

3.15 Desulphurisation of industrial gases with CFRI catalysts by N. G. Basak & A. Lahiri, Central Fuel Research Institute, Jealgora.

*3.16 Activated carbon industry in the context of national emergency by Regional Research Laboratory, Hyderabad.

*3.17 Economic factors in heavy chemicals manufacture by H. D. Edwards, M/s Shaw Wallace & Co. Ltd, Calcutta.

3.18 Anhydrous calcium sulphate—An all purpose desiccant by Abdul Hai & E. R. Saxena, Regional Research Laboratory, Hyderabad.

3.19 Preparation of phosphatic fertiliser without the use of sulphuric acid by E. R. Saxena, S. Kesavmurthy & K. Sambasiva Rao, Regional Research Laboratory, Hyderabad.

3.20 Activated earth for bleaching of cotton seed and lubricating oils by E. R. Saxena, M. K. H. Saddique & B. Farsinarie, Regional Research Laboratory, Hyderabad.

*3.21 Continuous production of aluminium trichloride by V. A. Altekar & S. D. Newalkar, Dept of Chemical Technology, University of Bombay, Bombay.

3.22 Continuous production of titanium tetrachloride from Indian ilmenites by V. A. Altekar & J. K. Sinha, Dept of Chemical Technology, University of Bombay, Bombay.

3.23 Water soluble phosphate fertiliser using nitric acid by G. T. Gadre & D. S. Datar, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

3.24 Manufacture of potassic fertiliser from distillery waste by R. N. Chakravarty, Central Public Health Engineering Research Institute, Nagpur.

3.25 Import substitution project—manufacture of organic fertilisers by M. V. Bopardikar & J. M. Dave, Central Public Health Engineering Research Institute, Nagpur.

*3.26 Production of sulphur dioxide and lime from gypsum as a new route for the manufacture of sulphuric acid by N. K. Mehra, Union Carbide India Ltd, Calcutta.

WORKING GROUP 4

Drugs & Pharmaceuticals, Medicinal & Aromatic Plants Public Health Engineering

4.1 Consideration of certain human factors for efficiency in industrial productivity by M. K. Chakrabarty, Central Mining Research Station, Dhanbad.

4.2 Comments from Dr M. L. Dhar, Central Drug Research Institute, Lucknow.

4.3 Comments from U. P. Basu, Bengal Immunity Research Institute, Calcutta.

4.4 Comments from R. S. Mehta, Central Public Health Engineering Research Institute, Nagpur.

4.5 Comments from R. B. Arora, All India Institute of Medical Sciences, New Delhi.

*4.6 Conditions essential for effective collaboration between industries and the research laboratories for the purposes of developing indigenous know-how, import substitution and process and product technology by C. V. Deliwala, Haffkine Institute, Bombay.

*4.7 Some technological problems in the production of drugs by S. P. Datta & A. Ray Chouduri, Bengal Immunity Research Institute, Calcutta.

*4.8 The problem of raw materials for pharmaceutical industry by M. L. Sen Gupta, A. Ray Chouduri & U. P. Basu, Bengal Immunity Research Institute, Calcutta.

4.9 Natural essential oils required in the manufacture of perfumery compounds by S. A. Hakim, A. Maschmeijer Jr (India) Private Ltd, Madras.

4.10 Jungle yams to hormones by R. N. Chakravarti, Department of Chemistry, School of Tropical Medicine, Calcutta.

*4.11 Self-sufficiency in raw materials for antibiotics production by C.N. Chari, J. M. Sehgal & M.C. Bhatia, Indian Drugs & Pharmaceuticals Ltd, Antibiotics Project, Virbhadra (Rishikesh).

*4.12 The organic constituents of coke oven by-products and their potential use as a raw material base for the pharmaceutical industry in India by H. S. Rao, S. K. Ray & A. Lahiri, Central Fuel Research Institute, Jealgora.

*4.13 Treatment of waste liquor from low temperature carbonisation by biological oxidation by P. K. Banerjee, S. R. Dutta Chowdhury, B. P. Das & A.N. Basu, Central Fuel Research Institute, Jealgora.

*4.14 Some problems facing pharmaceutical industry in relation to toxicological, chemical and pharmacological work in new drug research by V. Srinivasan, Sarabhai Chemicals Research Institute, Ahmedabad.

*4.15 Problems facing research efforts in pharmaceutical industry in India by V. Srinivasan, Sarabhai Chemicals Research Institute, Ahmedabad.

*4.16 Import substitution—A challenge to industry and government by S. M. Rangnekar, Synbiotics Ltd, Baroda.

4.17 Geranium plots in the cantonment area by K. V. Srinath, Central Indian Medicinal Plants Organisation, Zonal Office, Bangalore.

4.18 Public Health Engineering by S. Rajagopalan, Ministry of Health, New Delhi.

WORKING GROUP 5

Chemical Plant & Equipment, Electrical & Mechanical Engng, Cables Batteries, Power Plant, Agricultural, Textile and Mining Machinery, Automobiles

*5.1 Creation of adequate design and engineering facilities in the country and manufacture of plant and machinery and essential components hitherto imported by A. N. Kapur, National Research Development Corporation of India, New Delhi.

5.2 Indigenous development of railway equipment by L. K. Dhavan, Ministry of Railways, Railway Board, New Delhi.

5.3 Mining engineering equipment by S. Ramachandra, Central Mining Research Station, Dhanbad.

5.4 A note for discussion regarding safety equipment by G. N. Badami, Central Mining Research Station, Dhanbad.

5.5 Comments from S. A. Quader, Southern Regional Electricity Board, Bangalore.

5.6 Comments from Voltas Ltd, Bombay.

5.7 Comments from Tata Engineering & Locomotive Co. Ltd, Jamshedpur.

5.8 Comments from N. K. Sen Gupta, Hindustan Cables Ltd, Burdwan.

5.9 Comments from Atomic Energy Commission, Bombay.

5.10 Comments from K. N. Subbaraman, Neyveli Lignite Corporation Ltd, Neyveli.

5.11 Comments from S. R. Horner, Simon Carves India Ltd, Calcutta.

5.12 Comments from L. N. Misra, National Mineral Development Corporation Ltd, Jhunjhunu (Rajasthan).

5.13 Comments from Balwant Singh Nag, Irrigation & Power, Planning Commission, New Delhi.

5.14 Comments from S. M. Patil, Hindustan Machine Tools Ltd, Bangalore.

5.15 Comments from S.D. Mehta, Gujarat Refinery Projects, Baroda.

5.16 Comments from L. P. Mathur, Oil & Natural Gas Commission, Dehra Dun.

5.17 Equipment for hazardous locations by G. N. Badami, Central Mining Research Station, Dhanbad.

*5.18 Equipment for the pharmaceutical industry by R. P. De, Bengal Immunity Research Institute, Calcutta.

*5.19 Neyveli Lignite Corporation Ltd, Engineering aspects by Chairman, Neyveli Lignite Corporation Ltd, Neyveli.

*5.20 Substitution for requirements of welding electrodes industry by V. A. Altekar, Department of Chemical Technology, Bombay University, Bombay.

*5.21 Substitutes aluminium alloys in chemical industry by V. A. Altekar, Department of Chemical Technology, Bombay University, Bombay.

5.22 Indigenous manufacture of plant and equipment for power station by N. Venkatesan, Central Water & Power Commission, New Delhi.

*5.23 Chemical fabrication in India by O. P. Kharbanda, Larsen & Toubro Ltd, Bombay.

5.24 Note on mining equipment by S. Ramachandran, Central Mining Research Station, Dhanbad.

*5.25 Problems of corrosion of marine chemical process industries and in marine atmosphere by K. Seshadri, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*5.26 Feasibility studies on desalination of sea water plants for industrial cities of India by S. D. Gomkale, R. L. Datta & D. S. Datar, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*5.27 Sea water as coolant by S. D. Gomkale & R. L. Datta, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*5.28 Design of process equipments for marine chemicals by V. N. Lele, D.J. Mehta & D. S. Datar, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*5.29 Design of solar still for sea or brackish water desalination by S. V. Ahmed, S. D. Gomkale & R. L. Datta, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*5.30 Humidification-dehumidification technique for sea water desalination by S. K. Garg & R. L. Datta, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*5.31 Moulded insulation from magnesia and calcium silicate by H. V. Shah & D. J. Mehta, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*5.32 Development of a disperse salt washing column by M. M. Mohiddin, M. P. Bhat, R. K. Sapre, R. L. Datta & D. S. Datar, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*5.33 Design of salt harvester and mechanical soil stabiliser for salt works by R. P. Dhiman, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

5.34 Comments from Coffee Board, Bangalore.

5.35 Fuel efficiency in thermal power station by J. B. Singh, C/o M/s Sunila Singh, Indian Standards Institution, New Delhi.

5.36 Indigenous manufacture of electrical testing and measuring devices and explosion protected equipments, by C. D. Ayyar, Chief Electrical Engineer, Barauni Refinery, Barauni.

5.37 Extract from geophysical instrumentation by D. Gupta Sharma, National Geophysical Research Institute, Hyderabad.

*5.38 Indigenous design and construction facilities available in India by M. T. Shah, Indo Berolina Industries Pvt. Ltd, Bombay.

*5.39 Need of process design facilities for chemical plants in India by B. V. Bhoota, Chemical Plant Manufacturers Association, Bombay.

*5.40 Chemical plant design and construction in India by S. R. Poti, Kusum Products Ltd, Calcutta.

*5.41 Alkaline manganese dioxide wet cells by M. A. V. Devanathan, N. Ramaswami & S. Venkatesan, Central Electrochemical Research Institute, Karaikudi.

*5.42 Some aspects of research on batteries and their production by H. V. K. Udupa, Central Electrochemical Research Institute, Karaikudi.

*5.43 Light-weight portable high energy silver batteries by Prem Bihari Mathur, N. Karuppannan & R. Balasubramanian, Central Electrochemical Research Institute, Karaikudi.

5.44 Research on refrigeration at Central Mechanical Engineering Research Institute by M. M. Shah, Central Mechanical Engineering Research Institute, Durgapur.

5.45 Power development in India by D. Bhaduri, Central Mechanical Engineering Research Institute, Durgapur.

5.46 Role of heat and fluids division of Central Mechanical Engineering Research Institute in the national economy and scientific growth by B. K. Ray, Central Mechanical Engineering Research Institute, Durgapur.

5.47 Indigenous design—a case study of cable making machinery by R. N. Singhal, Central Mechanical Engineering Research Institute, Durgapur.

5.48 Research and development of farm machinery for increasing agriculture production in the country by Kartarsingh Yadav, Directorate of Extension, Ministry of Food & Agriculture, New Delhi.

*5.49 Research and development for import substitution in the electrical industry by K. C. Lall & S. Swayambu, Heavy Electricals Ltd, Bhopal.

*5.50 Glass-lining of chemical equipment. Regional Research Laboratory, Hyderabad.

*5.51 Import substitution of spares in organic chemical industry by R. M. Khandwala, Union Carbide (India) Ltd, Calcutta.

5.52 Vulcanisable polyethylene for power cables—a substitute for paper insulated lead sheathed cables by G. C. Motwani, Union Carbide (India) Ltd, Calcutta.

*5.53 Titanium for construction for chemical plants by S. L. Chawla, Indian Institute of Technology, New Delhi.

*5.54 Research and development—dry battery industry by N. C. Mehta, Union Carbide (India) Ltd, Calcutta.

5.55 Power supplies for electronic equipment—primary batteries by D. Krishnamurty, Union Carbide (India) Ltd, Calcutta.

*5.56 Semi-mechanised machine for preparing self set 85% magnesia insulation by R. N. Vohra & B. C. Thaker, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*5.57 Desalting saline waters with ion exchange materials by N. Krishnaswamy, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

5.58 Applications of silicon carbide in electrical industry by H. V. Gopala Krishna, Department of High Voltage Engineering, Indian Institute of Sciences, Bangalore.

5.59 Farm implements and machinery by C. S. Sridharan, Indian Council of Agricultural Research, New Delhi.

*5.60 Chemical plant designing in India—Its role in import substitution by Rajeswar Kumar Gupta, D.C.M. Chemical Works, New Delhi.

5.61 Development of jointing materials for the substitution of copper conductor with aluminium in insulated cabels by R. Dutta, Research Development Manager, Eyre Smelting Pvt. Ltd, Calcutta.

5.62 Comments from Calcutta State Transport Corporation, Calcutta.

5.63 Manufacture of materials and components for electrical industry by B. Choudhuri, H. T. Laboratory, Jadavpur University, Calcutta.

5.64 Testing and grading of welders by K. G. Chandiramani & S. Adikeshavan, Indian Institute of Technology, Kharagpur.

5.65 Capital equipment for the chemical industry by B. K. Banerjee, R. B. Barton & D. R. Sud, Imperial Chemical Industries, Calcutta.

5.66 Rubber gasket and rubber ring as substitute lead as pipe jointing material by J. M. Dave, Central Public Health Engineering Research Institute, Nagpur.

5.67 Manufacture of road making machinery in India by P. H. Bhavnani, Ministry of Transport, New Delhi.

*5.68 Self-sufficiency in power generating equipment by S. Swayambu, Heavy Electricals, Bhopal & V. Krishnamurthy, Bharat Heavy Electricals, New Delhi.

5.69 Towards attaining of technological self-sufficiency in the country—Contribution of the Central Engineering and Design Bureau of Hindustan Steel Ltd, by K. C. Mohan, C.E.&.D.B. Hindustan Steel Ltd.

*5.70 Gaps in the facilities of chemicals plant design in the country by M. D. Vijayaraghavan, Dorr-Oliver (India) Ltd, Bombay.

WORKING GROUP 6

Food, Agriculture, Agro-Industries, Fish, Meat, Coffee and Sugar, Tea, Industrial Crops, Oilseeds, Edible Oils

6.1 Comments on food substitutes by Voltas Ltd, Bombay.

6.2 Comments from Tata Oil Mills Co Ltd, Bombay.

6.3 Comments from Dr M. S. Randhawa, Intensive Agricultural Areas, Ministry of Food & Agriculture, New Delhi.

6.4 Comments from C. Gopalan, Nutrition Research Laboratory, Indian Council of Medical Research, Tarnaka, Hyderabad.

6.5 Comments received from the Managing Director, Central Warehousing Corporation, New Delhi.

6.6 Comments received from I. F. Morris, Chairman, Tea Research Association, Calcutta.

6.7 Comments received from Prof T. K. Ghose, Biochemical Engineering, Jadavpur University, Calcutta

6.8 Comments received from D. D. Dastur, National Dairy Research Institute, Karnal

6.9 Comments received from A. N. Bose, Director, Central Institute of Fisheries Technology, Ernakulam

6.10 Comments received from Dr H. A. B. Parpia, Central Food Technological Research Institute, Mysore.

6.11 Lipid resources and their fuller utilisation by C. R. Mitra, Utilisation Research Laboratory, National Botanical Gardens, Lucknow.

6.12 Sea weed and Indian industry by V. Krishnamurty, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*6.13 Sugar research in India by S. C. Gupta, Director, National Sugar Institute, Kanpur.

6.14 Studies on the performance of aluminised steel surface exposed to various processed foodstuffs by R. Dutta & T. K. Ghose, Department of Food & Biochemical Engineering, Jadavpur University, Calcutta.

*6.15 Problems in the development of fishing and fish processing industry in India by A.N. Bose, Central Institute of Fisheries Technology, Ernakulam.

*6.16 Scientific warehousing in public sector by P. M. Thomas, Storage Adviser, Central Warehousing Corporation, New Delhi.

6.17 Some problems in laying down Indian standard specifications for agriculture and food products by E. N. Sunder, Indian Standards Institution, New Delhi.

*6.18 Oils and fats by K. T. Achayya, Regional Research Laboratory, Hyderabad.

*6.19 Meat production, consumption and export by G. C. Juneja, Livestock Development Adviser, Ministry of Food & Agriculture, New Delhi.

*6.20 Weedicides from coal-tar fractions by M. S. Anand, C. S. B. Nair & A. N. Basu, Central Fuel Research Institute, Jealgora.

*6.21 Export oriented commodities: Tea, coffee, spices and cashew by Central Food Technological Research Institute, Mysore.

6.22 Fuels gas and manure from agriculture wastes by K. P. Goswami & S. Chowdhury, Central Fuel Research Institute, Jealgora.

6.23 Manufacture of agricultural chemicals—Prospects and problem by C. L. Dhavan, Union Carbide (India) Ltd, Calcutta.

6.24 Solvent extraction of cottonseed oil by Regional Research Laboratory, Hyderabad.

6.25 Cottonseed flour by Regional Research Laboratory, Hyderabad.

6.26 Cottonseed processing and products by Regional Research Laboratory, Hyderabad.

6.27 A new technique to fertilise soil by Gurudatt Singh, Karol Bagh, New Delhi.

*6.28 Modernisation of ricemilling machinery and practices in India by H. A. B. Parpia & H. S. R. Desikachar, Central Food Technological Research Institute, Mysore.

6.29 Role of waterproof irrigation channels in the agricultural economy of the country by H. L. Uppal, Central Road Research Institute, New Delhi.

*6.30 Economising sulphur in sugar manufacturing by B. L. Mittal, Dhampur Sugar Mills Ltd, Dhampur.

*6.31 Why the food crisis? by Central Food Technological Research Institute, Mysore.

6.32 Studies on brick tiles for use in canal lining by H. L. Uppal & Mohinder Singh.

*6.33 Vegetable proteins for substitution and supplementation of dairy products by M. R. Chandrasekharan, Central Food Technological Research Institute, Mysore.

*6.34 White sugar manufacture without sulphur by defecomelt crystallisation process by S. C. Gupta, National Sugar Institute, Kanpur.

*6.35 Some suggestions on import substitution in the dairy industry by A. T. Dudani, V. R. Bhalerao & M. R. Srinivasan, National Dairy Research Institute, Karnal (Punjab).

*6.36 Review of pesticide situation in India—Present situation and future trends by H. A. B. Parpia & S. K. Majumdar, Central Food Technological Research Institute, Mysore.

*6.37 Urgent requirements of the development of fruit and vegetable processing industries in the country by G. S. Siddappa, Central Food Technological Research Institute, Mysore.

*6.38 Proteins especially from oilseeds cakes and coconut cakes by (Miss) Radha Karnad, Directorate General of Health Services, New Delhi.

6.39 Common articles of agro-food vis-a-vis prevention of food adulteration by Y. K. Subrahmanyam, Directorate General of Health Services, New Delhi.

*6.40 Fuel economy in sugar industry by S. C. Gupta, National Sugar Institute, Kanpur.

6.41 Role of chemical industry in promoting agricultural production by K. V. Ramakrishnan, Imperial Chemical Industries Pvt. Ltd, Calcutta.

6.42 Agro-industries, their scope and development by A. N. Puri, Field Research Station, Bombay.

WORKING GROUP 7

Metallurgy, Iron & Steel, Non-ferrous Metals

*7.1 Substitute aluminium alloys in chemical industry by V. A. Altekar, University of Bombay, Bombay.

7.2 Comments from (Development of substitutes for imported raw materials) Voltas Ltd, Bombay.

7.3 Comments from Hindustan Aeronautics Ltd, Bangalore Division, Bangalore.

7.4 Comments received from Shri S. K. Nanavati, Tata Iron Steel Co. Ltd, Jamshedpur.

7.5 Comments received from D. D. Desai, B. Sayed, Abdulla Road, Bombay.

7.6 Use of bimetals in industries by Severaign Rolled Gold Manufacturers, Bombay.

7.7 Recovery of gallium and vanadium from bauxite by B. K. Handa, 28/12 A, Dhakuria Station Road, Calcutta.

*7.8 Aluminium alloys as substitutes for tin bronzes in bearing applications by S. Roy & R. Dutta, Eyre Smelting Pvt. Ltd, Calcutta.

*7.9 Construction metals for chemical plants—Indigenous availability by N. Thandavan; A.P.V. Engineering Co. Ltd, Calcutta.

7.10 A broad assessment of India's mineral position (excluding fuel and atomic minerals) by A. Roy, M. N. Qureshi, Harinarayan & S. Balakrishna, National Geophysical Research Institute, Hyderabad.

*7.11 What we do on aluminium to replace non-ferrous metals by A. Aravamuthan & B. A. Shenoi, Central Electrochemical Research Institute, Karaikudi.

7.12 A new approach to the production of metal powders from by-product metal oxides and hydroxides by H. V. K. Udupa, Central Electrochemical Research Institute, Karaikudi.

7.13 Surface treatment of steel prior to painting by K. S. Rajagopalan, Central Electrochemical Research Institute, Karaikudi.

7.14 Vapour phase corrosion inhibitors by K. S. Rajagopalan & N. Subramanyan, Central Electrochemical Research Institute, Karaikudi.

7.15 Aid to industry to fight corrosion by K. S. Rajagopalan & N. Subramanyan, Central Electrochemical Research Institute, Karaikudi.

7.16 A note on the work done on the extractive metallurgy of many common metals at Central Electrochemical Research Institute, Karaikudi by R. Srinivasan, Central Electrochemical Research Institute, Karaikudi.

7.17 Comments from Government Sandalwood Oil Factory, Mysore.

*7.18 Production of low ash and low phosphorus coals for carbide and ferroalloys by A. K. Moitra & G. G. Sarkar.

*7.19 Industrial semicokes from Orissa Coal for use in low shaft furnace by K. Y. Shrikhande & A. K. Moitra, Central Fuel Research Institute, Jealgora.

*7.20 Conservation of metallurgical coal by N. G. Banerjee & A. K. Moitra, Central Fuel Research Institute, Jealgora.

*7.21 Ductile iron castings—Scope for replacement of steel castings and forgings by S .K. Bhattacharjee & V. Venkateswarlu, Atomic Energy Establishment Trombay, Bombay.

7.22 Tantalum for electrolytic capacitors by P. K. Jena, S. K. Kantan, R. V. Raghavan, S. Srinivasan & V. Venkateswarlu, Atomic Energy Establishment Trombay, Bombay.

7.23 Production and industrial applications of zirconium by C. V. Sundaram & R. K. Garg, Atomic Energy Establishment Trombay, Bombay.

7.24 Fabrication of low expansion alloys for glass-to-metal seals by H. C. Katiyar, Atomic Energy Establishment Trombay, Bombay.

7.25 Comments from Electrosteel Castings Ltd, Calcutta.

7.26 Extraction of refractory metals by P. K. Jena, Atomic Energy Establishment Trombay, Bombay.

*7.27 The limits of economising copper in automobile radiators by J. G. Masilamani, India Radiators Ltd, Madras.

*7.28 Economic, industrial and chemical aspects of detinning industry by P. B. Mathur, N. Venkatakrishnan & R. L. Seth, Central Electrochemical Research Institute, Karaikudi.

7.29 Corrosion research and industry by K. N. P. Rao, Tata Iron & Steel Co. Ltd, Jamshedpur.

7.30 Metal research committee, Council of Scientific & Industrial Research by K. N. P. Rao, Tata Iron & Steel Co. Ltd, Jamshedpur.

7.31 Some aspects of zinc recovery from viscose plant wastes by K. L. Saxena, R. N. Chakravarty & M. V. Bopardikar, Central Public Health Engineering Research Institute, Nagpur.

7.32 Substitution of lead by rubber gasket & rubber ring as pipe jointing material by J. M. Dave, Central Public Health Engineering Research Institute, Nagpur.

*7.33 Strategic non-ferrous minerals and metals by Dr B. R. Nijhawan & C. Sharma, National Metallurgical Laboratory, Jamshedpur.

*7.34 Self-sufficiency in indigenous metals & alloys by V. Muthukrishnan, K.N. Srivastava, R. M. Krishnan & B. R. Nijhawan, National Metallurgical Laboratory, Jamshedpur.

WORKING GROUP 8

Paper, Pulp, Forestry, Textiles, Man-made Fibres, Wool, Leather, Plywood

*8.1 Leather industry and Research by Y. Nayudamma, Director, Central Leather Research Institute, Madras.

8.2 Comments from (Duplication and sensitised paper) Voltas Ltd, Bombay

8.3 Comments received from P. C. Mehta, Ahmedabad Textile Industry's Research Association, Ahmedabad.

*8.4 Scope for conservation and substitution of wool to the extent possible with synthetics in defence clothing by M. G. Kulkarni, Deputy Director, Wool Research Association, Bombay.

8.5 Comments from the Indian Cotton Mills Federation, Veer Nariman Road, Fort, Bombay.

8.6 Comments from S. R. Ranganathan, Shri Ram Institute for Industrial Research, Delhi.

8.7 Comments received from Shri A. D. Sule, Shri Ram Institute for Industrial Research, Delhi.

8.8 Comments received from Shri K. Manivannan, Shri Ram Institute for Industrial Research, Delhi.

*8.9 Improvement of Indian wool—Need for wool research programme by R. C. Ghosh, Defence Research Laboratory (Materials), Kanpur.

*8.10 Development of wool and woollen industry by Mallappa Kellur, Chameli Kunj, Bangalore.

*8.11 Problems and research needs of the Indian Cotton Textile Industry by P. C. Mehta, S. N. Bhaduri & T. Radhakrishnan, Ahmedabad Textile Industry's Research Association, Ahmedabad.

8.12 Comments from K. N. Murty, Director, Indian Bureau of Mines, Nagpur.

*8.13 Development of pulp and paper industry in India with special reference to raw materials by B. P. Chaliha, S. B. Lodh, M. S. Iyengar, Regional Research Laboratory, Jorhat.

*8.14 Ramie as an import supplement for flax and long staple cotton by S. Mukerji, Dept of Agriculture, West Bengal.

*8.15 Import substitution in textiles by C. Nanjundayya, Director, Bombay Textile Research Association, Bombay.

*8.16 Significance and scope of timber engineering by N. J. Masani, Forest Research Institute, Dehra Dun.

*8.17 Suggested research programmes in pulp, paper, forestry & man-made fibres by R. B. Bhatt, Century Rayons, Kalyan.

WORKING GROUP 9

Mining, Ores, Minerals, Geophysics, Oceanography

*9.1 Changeover from bord and pillar to longwall mining by A. B. Guha, Adviser (R), Planning Commission, New Delhi.

*9.2 Research and mining industry by K. N. Sinha & B. Singh, Central Mining Research Station, Dhanbad.

9.3 Pollution of mine atmosphere by J. K. Sinha, Central Mining Research Station, Dhanbad.

9.4 Comments from (industrial diamonds) Voltas Ltd.

*9.5 Colliery mechanisation by J. K. Sinha, Central Mining Research Station, Dhanbad.

*9.6 Export of upgraded bauxite of chromite by V. A. Altekar, Department of Chemical Technology, Bombay.

9.7 Research scheme for the industrial development of the minerals of Orissa by B. Sahoo, Lecturer in Chemistry, Indian Institute of Technology, Kharagpur and C. R. Das, Lecturer in Chemistry, B.J.B. College, Bhubaneshwar.

*9.8 A broad assessment of India's mineral position (excluding fuel and atomic minerals) by A. Roy, M. N. Kureshi, Harinarian & S. Balakrishna, National Geophysical Research Institute, Hyderabad.

9.9 Comments from K. N. Murthy, Indian Bureau of Mines, Nagpur.

*9.10 Oceanography as applied to industry by N. K. Panikkar & R. Jayaraman, Indian Ocean Expedition, New Delhi.

*9.11 Development of the asbestos mining industry of Andhra Pradesh by K. V. Subramanyam, Director, Andhra Pradesh Mining Corporation Ltd, Hyderabad.

*9.12 Problems of self-sufficiency in mineral industry by A. G. Jhingran, Director-General, Geological Survey of India, Calcutta.

*9.13 Investigations on nickel bearing laterites in India by A. N. Chowdhury, Geological Survey of India, Calcutta.

*9.14 Ground water resources of Mysore and their utilisation by B. P. Radhakrishna, Dept of Mines & Geology, Bangalore.

WORKING GROUP 10

Petroleum Refining, Petrochemicals, Petroleum Technology and Oil & Gas Exploration

10.1 Comments received from S. D. Mehta, Gujarat Refinery Project, Baroda.

10.2 Extract from geophysical instrumentation by D. Gupta Sharma, National Geophysical Research Institute, Hyderabad.

10.3 Utilisation of iomex by catalytic hydrogenation by A. N. Basu, H. S. Rao, A. K. Ganguly & N. G. Basak, Central Fuel Research Institute, Jealgora.

10.4 Catalytic hydrogenation of straight run kerosene distillates by S. K. Bose, A. K. Ganguly, A. N. Basu & N. G. Basak, Central Fuel Research Institute, Jealgora.

*10.5 The case for setting up an indigenous oilfield equipment industry: A report from Oil India Ltd, New Delhi.

*10.6 Manufacture of oilfields chemicals in India: A report from Oil India Ltd, New Delhi.

*10.7 Is the need of special cement for oil-well drilling in India over-emphasised? by F. Shikhalior & S. N. Bhattacharya, Oil & Natural Gas Commission.

10.8 Oil and emergency by S. N. Verma, Banaras Hindu University, Varanasi.

*10.9 Testing facilities available at IIP for certification (Performance Mechanical Tests) by J. R. Thiery & R. A. Rao, Indian Institute of Petroleum, Dehra Dun.

*10.10 Import substitution in petroleum industry by H. K. Joshi, ESSO.

WORKING GROUP 11

Energy, Coal

11.1 Development of a new technique for upgrading of fine coal and beneficiation of inferior grade coals by A. B. Guha, Adviser (R), Planning Commission, New Delhi.

11.2 Production of cheap smokeless solid fuel for domestic use by A. B. Guha, Adviser (R), Planning Commission, New Delhi.

11.3 Underground gasification of coal by A. B. Guha, Adviser (R), Planning Commission, New Delhi.

11.4 Comments from A. Lahiri, Central Fuel Research Institute, Jealgora.

11.5 Theoretical considerations on the value of coal petrography in coke studies on Chirnoiri coal (M.P.) India by S. K. Basu, Department of Applied Geology, Saugar University, Saugar (M.P.)

11.6 Role of nuclear techniques in industry by P. K. Aditya, Indian Institute of Technology, New Delhi.

11.7 Low temperature carbonisation potentialities of Indian coals by K. Y. Khande & A. K. Moitra, Central Fuel Research Institute, Jealgora.

11.8 Development of an efficient domestic oven for burning processed solid fuel by A. K. Moitra & S. K. Das Gupta, Central Fuel Research Institute, Jealgora.

11.9 Upgrading of coal: Central Fuel Research Institute's contribution by A. K. Chakravarty & R. N. Bose, Central Fuel Research Institute, Jealgora.

11.10 Developments in total gasification of coal by S. K. Das Gupta & M. Sen, Central Fuel Research Institute, Jealgora.

11.11 Quality survey of Indian coals and its influence on the planning for future coal utilisation by S. Bagchi & N. C. Sinha, Central Fuel Research Institute, Jealgora.

11.12 Low temperature carbonisation by Regional Research Laboratory, Hyderabad.

*11.13 Role of coal research in energy development by S. Bagchi & A. Lahiri, Central Fuel Research Institute, Jealgora.

11.14 Utility of coal petrology to science and industry by S. K. Basu, Geological Society, University of Saugar, Saugar.

11.15 Research on coal with special reference to its utilisation in specific industries and its additional resources in the country by P. K. Ghosh, Geological Survey of India, Calcutta.

11.16 A review of the current problems of Indian coals and some suggested solutions by P. Kar & S. Roy, Indian Bureau of Mines, Nagpur.

11.17 The realities of the coal industry of India (excluding Assam) by K. N. Subrahmanyam, Professor of Mining Engineering, Osmania University, Hyderabad.

*11.18 Scope for participation of the Indian industry in the atomic power programme by V. N. Meckoni, Atomic Energy Establishment Trombay, Bombay.

WORKING GROUP 12

Glass, Ceramics, Enamels, Clays & Refractories, Mica

12.1 Comments from H. K. Mitra, Kumardhubi Fireclay & Silica Works Ltd, Calcutta.

*12.2 Substituting magnesite by sea water magnesia in the manufacture of refractory magnesia by R. K. Shukla & R. N. Vohra, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*12.3 Research and industry in refractories by P. K. Paul, Durgapur Steel Plant, Durgapur.

12.4 Comments from K. N. Murty, Indian Bureau of Mines, Nagpur.

12.5 Indigenous refractory materials as substitutes for imported materials by M. R. Prasad, Tata Iron & Steel Co. Ltd, Jamshedpur.

*12.6 Urgent problems facing the refractory industry by D. R. Subrahmanian, Burn & Co. Ltd, Calcutta.

*12.7 Raw material situation for the production of basic bricks by J. D. Pande, Orissa Cement Ltd, Orissa.

WORKING GROUP 13

Aeronautical Engineering: Aircraft Structures, Materials Propulsion, Systems, Aviation Fuel

13.1 Jet fuels from coal by A. N. Basu & A. K. Ganguly, Central Fuel Research Institute, Jealgora.

13.2 Some thoughts on aeronautical research and development activities for promoting the manufacturing industry by S. Ramamritham, Technical Centre, Civil Aviation Department, New Delhi.

WORKING GROUP 14

Buildings, Roads, Civil Engineering Materials

14.1 Comments from H. P. Sinha, Joint Secretary, Ministry of Transport, New Delhi.

14.2 Comments from Jai Krishna, School of Research and Training in Earthquake Engineering, Roorkee.

14.3 Comments from G. Pande, University of Roorkee, Roorkee.

14.4 Comments from S. R. Mehra, Director, Central Road Research Institute, New Delhi.

14.5 Comments from A. Lahiri, Central Fuel Research Institute, Jealgora.

*14.6 Prospects for light-weight aggregates by S. M. K. Chetty, Central Building Research Institute, Roorkee.

*14.7 A proposal for the manufacture of aerated concrete in India by S. K. Chopra, C. A. Taneja & S. P. Tehri, Central Building Research Institute, Roorkee.

*14.8 Problems of implementation of building research by M. H. Pandya, Central Building Research Institute, Roorkee.

14.9 Development of light-weight aggregates and concrete by S. K. Chopra, Central Building Research Institute, Roorkee.

*14.10 Asbestos cement building work by S. K. Swami, Working Director, Asbestos Cement Ltd, Bombay.

*14.11 Role of soil stabilisation in salt industry by B. S. Joshi, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*14.12 Sorel Cement by B. K. Shukla & P. N. Trivedi, Central Salt & Marine Chemicals Research Institute, Bhavnagar.

*14.14 Shock resistant design of structures by Jaikrishna, A. S. Arya, A. R. Chandrasekaran & S. Prakash, School of Research & Training in Earthquake Engineering, University of Roorkee, Roorkee.

14.15 Comments from Neyveli Lignite Corporation Ltd, Neyveli.

*14.16 Central Mechanical Engineering Research Institute's research on industrial structures by K. V. Shetty, Central Mechanical Engineering Research Institute, Durgapur.

*14.17 Utilisation of indigenous amphibole variety of asbestos for production of asbestos cement sheets and pipes by N. G. Basak & A. Lahiri, Central Fuel Research Institute, Jealgora.

*14.18 Self-sufficiency in cement during the Fourth Five-Year Plan by Y. C. Gokhle, Regional Research Laboratory, Jorhat.

14.19 New methods and materials adopted for import substitution in civil construction at foundry forge project Ranchi by K. M. Jha, Foundry Forge Project, Heavy Engineering Corporation, Ranchi.

14.20 Use of rubber bearings for highway bridges by Roy Chowdhuri, Central Road Research Institute, New Delhi.

*14.21 Need for urban traffic transportation planning by N. S. Srinivasan, Central Road Research Institute, New Delhi.

*14.22 Role of national laboratories in design consultancy services in foundation engineering by T. K. Natarajan, Central Road Research Institute, New Delhi.

*14.23 Note for discussion on indigenous manufacture of road making machinery by Central Road Research Institute, New Delhi.

*14.24 Lime reactive surkhi mixture as substitute for cement in masonry mortars and plasterings by B. K. Ghosh & N. R. Srinivasan, Central Road Research Institute, New Delhi.

*14.25 A note on coconut pith expansion joint filler and building boards by K. L. Seth & R. K. Ghosh, Central Road Research Institute, New Delhi.

*14.26 Soil as a new material of engineering construction in the economic development of India by H. L. Uppal, Central Road Research Institute, New Delhi.

*14.27 Utilisation of results of road research by Central Road Research Institute, New Delhi.

*14.28 Some thoughts on bituminous materials in road construction by C. G. Swaminathan, Central Road Research Institute, New Delhi.

*14.29 Promoting utilisation of results of research in building by G. C. Mathur, National Buildings Organisation, New Delhi.

*14.30 A quick and economical method of road construction in desert areas by I. S. Uppal, PWD (B & R) Research Laboratory, Chandigarh.

*14.31 Sugar pressed mud as a road building material by I. S. Uppal, PWD (B & R), Research Laboratory, Chandigarh.

*14.32 Lime surkhi-sand block for river training works by H. L. Uppal & Mohinder Singh, Land Reclamation, Irrigation & Power Research Institute, Amritsar.

*14.33 A study of effect of addition of lime putty and lime putty surkhi combinations on cement mortars for use in masonry structure by H. L. Uppal & Mohinder Singh, Land Reclamation, Irrigation & Power Research Institute, Amritsar.

14.34 Mixed feed lime kiln by H. L. Uppal & Mohinder Singh, Land Reclamation, Irrigagation & Power Research Institute, Amritsar.

14.35 Problems of cement adulteration by A. N. Puri, Field Research Station, Bombay.

*14.36 Significance and scope of timber engineering for economic development of construction industry by N. J. Masani, Forest Products Research FRI & Colleges.

WORKING GROUP 15

Research Utilisation, Cooperation between Research & Industry, Policies on Research & Development

15.1 A plea for research within the chemical industry by K. Venkataraman, National Chemical Laboratory, Poona (reprinted from *Chem. & Ind.*)

*15.2 Organising research for industry by S. K. Subramanian, National Chemical Laboratory, Poona.

*15.3 Planning and promoting industrial research by A. C. Ray, Director (S.R.), Planning Commission, New Delhi.

*15.5 Is Indian industry shy to adopt Indian processes? by G. S. Chowdhury, Regional Research Laboratory, Bhubaneshwar.

15.6 Promotion of research in industry by A. N. Kapur, Executive Director, National Research Development Corporation of India, New Delhi.

15.7 Orientation of industrial research programmes to meet the needs of the industry by A. N. Kapoor, National Research Development Corporation of India, New Delhi.

15.8 Development and utilisation of indigenous know-how by A. N. Kapoor, National Research Development Corporation of India, New Delhi.

15.9 Development of substitutes for imported raw materials by A. N. Kapoor, National Research Development Corporation of India, New Delhi.

15.10 Development of techniques for improving economics of production and utilisation of wastes by A. N. Kapoor, National Research Development Corporation of India, New Delhi.

*15.11 Comments from G. P. Chatterjee, Hindustan Steel Limited, Durgapur.

*15.12 Applied research by V. G. Rajadhyaksha, Hindustan Lever Limited, Bombay.

15.13 Comments from John K. John, E. I. D. Parry Ltd, Madras.

15.14 Comments from Khadi & Village Industries Commission.

15.15 Comments from S. N. Sehgal, Ministry of Steel & Mines, New Delhi.

15.16 Comments from C. S. Rao, Defence Research Development Organisation, Dehra Dun.

15.17 Comments from R. N. Chakravarty, Calcutta School of Tropical Medicine, Calcutta.

15.18 Comments from K. Sreenivasan, South India Textiles Research Association, Coimbatore.

15.19 Comments from Dr T. S. Subramanian, Indian Jute Mills Association, Calcutta.

15.20 Comments from S. J. Shah, Aniline Dyestuffs & Pharmaceuticals Pvt. Ltd, Bombay.

15.21 Comments from Dr A. R. Verma, National Physical Laboratory, New Delhi.

15.22 Comments from Dr B. D. Tilak, National Chemical Laboratory, Poona.

15.23 Comments from J. N. Nanda, Director, Ministry of Defence, Defence Research Laboratory (Materials), Kanpur.

15.24 Comments from C. P. Shah, Bombay Potteries Tiles Ltd, Bombay

15.25 Comments from G. P. Kapur, Under Secretary, Prime Minister's Secretariat, New Delhi.

15.26 Comments from Prof. S. V. C. Aiya, Dept of Electrical Communication Engineering, Indian Institute of Science, Airconditioning Corporation Ltd, Calcutta.

*15.27 Imported technology and national development by J. C. Kapur, Airconditioning Corporation, Ltd. Calcutta.

15.28 Note on the cooperation between research and industry by Dr U. P. Basu, Bengal Immunity Research Institute, Bombay.

15.29 Effective collaboration between research and industry, by D. U. Deliwala, Haffkine Institute, Bombay.

*15.30 Role of cooperation between research and industry by Y. A. Fazalbhoy, Radio and Appliances Ltd, Bombay.

15.31 Self-sufficiency in agriculture and industry by M. A. Govindarajan, Office of the Economic Adviser, Ministry of Industry & Supply, New Delhi.

15.32 Comments from Dr T. S. Subramanian, Indian Jute Mills Association, Calcutta.

15.33 Some thoughts on research in teaching institutions by S. K. Garg & J. P. Sharma, Dept of Mechanical Engineering, Indian Institute of Technology, New Delhi.

15.34 Need for manufacture of scientific equipment and biochemicals by J. B. Srivastava, National Institute of Communicable Diseases, Delhi.

15.35 Comments from J. Verghese, Shri Ram Institute for Industrial Research, Delhi.

*15.36 Increasing effectiveness of research for industrial and economic developments by P. C. Mehta, Director, Ahmedabad Textile Industry's Research Association, Ahmedabad.

15.37 Role of applied and basic objective research in the development of chemical industry in India by S. K. Bhattacharyya, Prof. & Head of the Dept of Applied Chemistry, Indian Institute of Technology, Kharagpur.

15.38 How Britain did it? by Dr M. S. Iyengar, Regional Research Laboratory, Jorhat.

*15.39 Cooperative research and industry by G. S. Ramakrishnan, Hindustan Ferodo Ltd, Bombay.

*15.40 Development of indigenous technical know-how by S. S. Mehta & S. S. Nadkarni, Industrial Credit & Investment Corporation of India, Bombay.

*15.41 Scientific research for the development of indigenous know-how by M. M. Suri, Director, Central Mechanical Engineering Research Institute, Durgapur.

*15.42 Applied research related to material and product control by Audum Ofjord,, Central Mechanical Engineering Research Institute, Durgapur.

*15.43 Research and industry by S. K. Dutta, General Manager, Burn & Co. Ltd, Howrah.

15.44 Some suggestions to vitalise research and design manpower by K. N. Sundaram, Institute of Applied Manpower Research, New Delhi.

*15.45 Translation of laboratory research to commercial products through development work by K. Manivannan, Shri Ram Institute for Industrial Research, Delhi.

*15.46 Financial control of industrial research by J. Dubashi, Economic & Scientific Research Foundation, New Delhi.

*15.47 Role of coal research in energy development by S. Bagchi & A. Lahiri, Central Fuel Research Institute, Jealgora.

15.48 Effect of foreign collaboration on Indian industry and indigenous research by P. K. Srivastava, Institute of Social Sciences, Agra University, Agra.

15.49 Points for discussion by S. B. Sen, Aligarh Muslim University, Aligarh.

*15.50 Import substitution and conservation of scarce materials—Scope for research and standardisation by Gurcharan Singh, Indian Standards Institution, New Delhi.

15.51 On cooperation and coordination between research and industry by S. N. Verma, Dept of Geology, Banaras Hindu University, Varanasi.

*15.52 A perspective on considerations for research and development policies by Bgr. B. M. Chakravarti, Electronics & Radar Development Establishment, Bangalore.

15.53 Scientists for industry by Dr B. K. Nayar, National Register, Council of Scientific & Industrial Research, New Delhi.

*15.54 Need for a change in manpower policy by K. Ray, National Register, Council of Scientific & Industrial Research, New Delhi.

*15.55 Suggestions for rapid growth of industrial research in India by Dr S. L. Mukerjee, Sarabhai Chemicals, Baroda.

15.56 Productivity in the chemical industry: An aim of research and technological development by A. K. Mukerjee, Work Study Department, Imperial Chemical Industries, Calcutta.

15.57 Technical information: The basic need for industrialisation by K. J. Thaker, Inventions Promotion Board, New Delhi.

15.58 Research and its development in India by J. C. Maheshwary, Directorate-General of Technical Development, New Delhi.

15.59 Foreign exchange through patent agency services for foreign inventions in India by R. B. Pai, Patent Officer, CSIR, New Delhi.

15.60 Import substitution (A synopsis of the activities in search of substitute materials undertaken by the P & T workshop organisation) by General Manager, P & T Workshops, Calcutta.

15.61 Import substitution by A. L. Sabharwal, Indian Aluminium Co. Ltd, Calcutta.

15.62 Industrial utilisation of research and national emergency by V.B. Srivastava, K. N. Srivastava & B. R. Nijhawan, National Metallurgical Laboratory, Jamshedpur.

*15.63 Some aspects of the organisation of research by B. Rye, ICI (India) Ltd, Calcutta.

*15.64 Coordination between research and industry by S. C. Doshi & W. W. Robertson, Indian Aluminium Co. Ltd, Calcutta.

15.65 Research & Industry by S. M. Shah, Polychem. Ltd., Bombay.

15.66 Importance of particle size studies in industrial research and development by S. Guruswamy, Central Mining Research Station, Dhanbad.

15.67 Defence research & industry—Some general considerations by G. K. Rao, R & D Organisation, Ministry of Defence, New Delhi.

APPENDIX 2

Composition of Working Groups

WORKING GROUP 1

Electronics, Instruments, Radio, Television, Public Address Systems other Appliances

Chairman

Shri C. P. Vasudevan
Director, Telecommunication Research Centre, D.G.P. & T., New Delhi

Convener

Dr Amarjit Singh
Director, Central Electronics Engineering Research Institute, Pilani

Members

Shri Y. A. Fazalbhoy
General Radio & Appliances Ltd, Bombay

Shri P. N. Deobhakta
Ministry of Industry & Supply, New Delhi

Dr G. R. Toshniwal
Toshniwal Brothers, Bombay

Brig. B. J. Shahaney
Research & Development Organisation
Ministry of Defence, New Delhi

Mr A. S. Rao
Director, Electronics Group, Atomic Energy Establishment, Bombay

Dr A. R. Verma
Director, National Physical Laboratory
New Delhi

WORKING GROUP 2

Industrial Organic Chemicals, Biochemicals, Dyes and Intermediates, Rubber Resins, Adhesives, Plastics, Paints, Varnishes, Surface Coatings

Chairman

Shri S. J. Shah
Aniline Dyestuffs & Pharmaceuticals Pvt Ltd, Bombay

Convener

Dr B. D. Tilak
Joint Director, National Chemical Laboratory, Poona

Members

Dr C. J. Dadachanji
Managing Director, National Organic Chemical Industries Ltd, Bombay

Dr D. M. Trivedi
Project Manager, Synthetics & Chemicals Ltd, Bombay

Dr W. D. Patwardhan
Explosives Research & Development Laboratory, Poona

Dr Y. Nayudamma
Director, Central Leather Research Institute
Madras

Shri N. Srinivasan
Industrial Adviser, Directorate-General of Technical Development, New Delhi

Prof. N. R. Kamath
Deputy Director, Indian Institute of Technology, Bombay

WORKING GROUP 3

Inorganic and Heavy Chemicals, Fertilisers, Cement, Marine Chemicals

Chairman

Dr S. K. Mukherjee
General Manager, Fertilizer Corporation of India Ltd, Durgapur

Convener

Dr R. C. Mehrotra
University Professor of Chemistry, and Dean
Faculty of Science, Univ. of Rajasthan Jaipur

Members

Dr J. Gupta
Scientist, National Chemical Laboratory Poona

Dr H. Nath
Director, Directorate of Research (Laboratories), Research and Development Organisation, Ministry of Defence, New Delhi

Dr A. K. Chatterji
Works Manager, Indian Detonators Ltd Hyderabad

Shri P. K. Seshan
Development Officer, Directorate-General of Technical Development, New Delhi

Dr N. N. Sharma
Scientist, Central Salt & Marine Chemicals Research Institute, Bhavnagar

WORKING GROUP 4

Drugs & Pharmaceuticals, Medicinal & Aromatic Plants Public Health Engineering

Chairman

Dr H. A. Hamied
CIPLA, Bombay

Convener

Dr Nitya Nand
Scientist, Central Drug Research Institute Lucknow

Members

Shri A. V. Modi
Director, Unichem Laboratory, Bombay

Dr B. Shah
Industrial Adviser, Directorate-General of Technical Development, New Delhi

Dr S. C. Bhattacharya
Scientist, National Chemical Laboratory Poona

Dr S. Rohatgi
Hind Chemicals, Kanpur

Dr A. C. Roy
Scientist, Central Drug Research Institute Lucknow

WORKING GROUP 5

Chemical Plant & Equipment, Electrical & Mechanical Engineering, Cables Batteries, Power Plant, Agricultural, Textile and Mining Machinery, Automobiles

Chairman

Dr B. D. Kalelkar
Deputy Director-General, Directorate-General of Technical Development, New Delhi

Conveners

Shri M. M. Suri
Director, Central Mechanical Engineering Research Institute, Durgapur

Dr K. S. Chari
Scientist-in-Charge, Central Design & Engineering Organisation, New Delhi

Members

Col. B. Basu
Managing Director, Indian Mechanisation & Allied Products Ltd, Calcutta

Shri P. C. Kapur
Director-General, Technical Development, Ministry of Industry & Supply, New Delhi

Shri Pran Lal Patel
President, All India Automobile & Ancillary Industries Association, Bombay

Shri T. R. Gupta
Chairman, Heavy Engineering Corp. Ranchi

Shri Hari Bhusan
Director (Engg), Planning Commission New Delhi

WORKING GROUP 6

Food, Agriculture, Agro-Industries, Fish, Meat, Sugar, Tea, Coffee Industrial Crops, Oilseeds, Edible Oils

Chairman

Shri P. A. Narielwala
Tata Industries Pvt Ltd, Bombay

Conveners

Dr H. A. B. Parpia
Director, Central Food Technological Research Institute, Mysore

Dr K. T. Achaya
Scientist, Regional Research Laboratory Hyderabad

Members

Prof. J. G. Kane
Department of Chemical Technology University of Bombay, Bombay

Dr Sadgopal
Deputy Director, Indian Standards Institution, New Delhi

Shri C. V. Mariwala
Bombay Oil Industries, Bombay

Dr S. Varadarajan
Hindustan Lever Ltd, Research Laboratory Bombay

Shri M. A. Wadud Khan
Tata Oil Mills, Bombay

Shri N. Srinivasan
Adviser (Chem.), Directorate-General of Technical Development, New Delhi

Shri V. Kurien
Kaira Distt Cooperative Milk Producers Union Ltd, Anand (Gujarat)

Dr B. L. Amla
Scientist, Central Food Technological Research Institute, Mysore

Shri K. M. Dastur
Scientist, Central Food Technological Research Institute, Mysore

WORKING GROUP 7

Metallurgy, Iron & Steel, Non-ferrous Metals

Chairman

Dr Brahm Prakash
Director, Metallurgy Group, Atomic Energy Establishment Trombay, Bombay

Convener

Dr B. R. Nijhawan
Director, National Metallurgical Laboratory Jamshedpur

Members

Dr P. Dayal
Development Officer (Metals), Directorate-General of Technical Development, New Delhi

Dr R. V. Tamhankar
Director, Defence Metallurgical Research Laboratory, Hyderabad

Dr D. Swarup
Chief (Metals), Planning Commission, New Delhi

Shri K. N. P. Rao
Technical Adviser to the General Manager, Tata Iron & Steel Co. Ltd, Jamshedpur

Shri P. R. Kamani
Managing Director, Kamani Metals and Alloys Ltd, Bombay

Shri Arjan Vaswani
Secretary, Institute of Indian Foundrymen Calcutta

Shri S. S. Gill
Technical Expert (PE), Department of Industries, Govt of Punjab, Chandigarh

WORKING GROUP 8

Paper, Pulp, Forestry, Textiles, Man-made Fibres, Wool, Leather, Plywood

Chairman

Dr A. Seetharamiah
Industrial Adviser, Directorate-General of Technical Development, New Delhi

Convener

Dr P. C. Metha
Director, Ahmedabad Textile Industry's Research Association, Ahmedabad

Members

Dr R. V. Bhatt
Century Rayons Ltd, Bombay

Dr V. K. Vyas
Gwalior Rayons Ltd, Gwalior

Dr S. K. Barat
Scientist, Central Leather Research Institute Madras

Dr D. Narayanamurti
Director, Indian Plywood Industries Research Association, Bangalore

WORKING GROUP 9

Mining, Ores, Minerals, Geophysics, Oceanography

Chairman

Shri A. G. Jhingran
Director-General, Geological Survey of India, Calcutta

Convener

Dr Hari Narain
Director, National Geophysical Research Institute, Hyderabad

Members

Prof. K. V. Subramanyam
Professor of Mining Engineering, College of Engineering, Osmania University Hyderabad

Dr B. P. Radhakrishna
Director of Mines & Geology, Bangalore

Dr Amalendu Roy
Deputy Director, National Geophysical Research Institute, Hyderabad

WORKING GROUP 10

Petroleum Refining, Petrochemicals, Petroleum Technology Oil & Gas Exploration

Chairman

Shri N. N. Kashyap
Managing Director, Refineries Division New Delhi

Convener

Dr M. G. Krishna
Director, Indian Institute of Petroleum Dehra Dun

Members

Shri N. C. Krishnamurthy
Deputy Chemical Engineer, Oil & Natural Gas Commission, New Delhi

Shri H. C. Aggarwal
Executive Engineer, Indian Oil Corporation Ltd (Refineries Division), New Delhi

Shri M. Kurien
Head, Projects Division, Indian Institute of Petroleum, New Delhi

WORKING GROUP

Energy, Coal

Chairman

Shri A. B. Guha
Adviser (R), Planning Commission New Delhi

Convener

Dr M. S. Iyengar
Director, Regional Research Laboratory Jorhat

Members

Shri M. K. Gopaliyengar
Chief (Power), Irrigation and Power Division Planning Commission, New Delhi

Shri V. N. Meckoni
Atomic Energy Establishment Trombay Bombay

Shri A. K. Das Gupta
Bhilai Steel Project, Bhilai

Dr S. K. Mukherjee
General Manager, Fertilizer Corporation of India Ltd, Durgapur Division, Calcutta

Shri S. Bagchi
Deputy Director, Central Fuel Research Institute, Jealgora

WORKING GROUP 12

Glass, Ceramics, Enamels, Clays & Refractories, Mica

Chairman

Dr S. P. Varma
Industrial Adviser, Directorate-General of Technical Development, New Delhi

Convener

Shri K. D. Sharma
Scientist, Central Glass & Ceramics Research Institute, Calcutta

Members

Shri N. R. Srinivasan
Development Officer, Directorate-General of Technical Development, New Delhi

Shri S. R. Khanna
Development Officer (Glass), Directorate-General of Technical Development, New Delhi

Shri B. B. Sarkar
Managing Director, Krishna Silicate & Glass Works Ltd, Calcutta

Dr S. S. Ghosh
Chief Superintendent (Iron & Steel) Hindustan Steel Ltd, Bhilai

Shri R. M. Mehra
Bombay Potteries & Tiles Ltd, Bombay

WORKING GROUP 13

Aeronautical Engineering : Aircraft Structures, Materials, Propulsion Systems, Aviation Fuel

Chairman

Shri Raj Mahindra
Senior Design Engineer, Hindustan Aeronautics Limited, Bangalore

Convener

Dr S. R. Valluri
Director, National Aeronautical Laboratory Bangalore

Members

Shri D. M. Rao
Scientist, National Aeronautical Laboratory Bangalore

Shri S. N. B. Murthy
Scientist, National Aeronautical Laboratory Bangalore

Prof. C. V. Joga Rao
Professor of Aeronautical Engineering, Indian Institute of Science, Bangalore

Wg Cdr. S. N. Roy Chaudhury
Officer-in-Charge, Gas Turbine Research Establishment, Bangalore

Shri S. Ramamritham
Director, Directorate-General of Civil Aviation, New Delhi

WORKING GROUP 14

Buildings, Roads, Civil Engineering Materials

Chairman

Shri G. Pande
Vice-Chancellor, University of Roorkee Roorkee

Convener

Dr H. L. Uppal
Scientist, Central Road Research Institute New Delhi

Members

Shri C. B. Patel
Director, National Buildings Organisation New Delhi

Dr H. C. Visvesvaraya
Deputy Director, Indian Standards Institution, New Delhi

Shri T. K. Natarajan
Scientist, Central Road Research Institute New Delhi

Dr S. K. Chopra
Scientist, Central Building Research Institute, Roorkee

WORKING GROUP 15

Research Utilisation, Cooperation between Research & Industry, Policies on Research & Development

Chairman

Shri S. S. Mehta
Industrial Credit & Investment Corpn of India Ltd, Bombay

Convener

Shri Baldev Singh
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